SCIENTIFIC AMERICAN

THE MAGAZINE OF TODAY AND TOMORROW

NEW YORK, MARCH, 1926 EIGHTY-SECOND YEAR

WASTE

WE are a very rich people. Part of our wealth is due to our ceaseless industry, and part—the greater part—to our enormously rich natural resources—coal, oil, iron ore, magnificent forests. But, for three hundred years, we have been wasting our patrimony. Commencing in our April issue, J. Bernard Walker will tell you in a series of articles, to be published throughout the year, just how extravagant we have been, and what means are being taken by the Government to stop the waste and repair the damage.

RESOURCES

MANY and powerful are the arguments for enforcing a strict conservation of our natural resources and not the least of these is based on the rapid growth of our population. At the last gathering of the American Statistical Association, it was predicted that in the year 2000, New York would have a population of 11,880,000. Shall we be able to feed them? "Yes," says Dr. O. E. Baker, "provided we develop our agricultural lands. We can develop our agricultural resources to support 250,000,000 people; and if we were to use the methods of intensive cultivation of Germany and Denmark, we could support over 400,000,000 people." These are startling figures, but they are based on a thorough study by the most expert minds in this field of research.

EDUCATION

IN his annual report as president of Columbia University, Dr. Nicholas Murray Butler sets at the apex of the world's problems the disappearance of "broad men."

"The plain fact is that early and intense specialization is at the bottom of the trouble," he declares. "Specialization is the parent of information and of a certain type of skill, but it is the foe of knowledge and the mortal enemy of wisdom. Not narrow men, however keen, but broad men sharpened to the point, are the ideal product of a sound system of school and college education."

An excellent statement in which we heartily concur. The broad man must not shrink when his days within academic walls are over. He must keep up with the achievements of the leaders of thought and action, not only in his own narrow segment, but in the whole sphere of human action. He must know what is going on and what it is all about.

Or, to carry on Dr. Butler's simile, the broad man's fine point must not be permitted to grow dull from lack of use. Constantly it must be whetted on the swiftly turning wheel of progress.

In This Issue

The Truth About the New Cosmic Ray
Rays that reach the earth from some unknown outside source have proved to be far more penetrative than X rays. Much unscientific nonsense has already been written about them. Commencing on page 149, Prof. Millikan, the scientist who found out what we know about them, tells you the truth.

Which Mounting for Your New Telescope?
Last month Mr. Porter told you how to make the marvelously accurate mirror for a reflecting telescope. This month, starting on page 164, he explains the fundamental principles of telescope mountings.

What Destroyed This Budding Civilization?
Proof has been discovered that centuries ago the Vikings founded a thriving colony in Greenland. Came adversity, changing climate, unknown causes. The colony died out—was forgotten. Now we find its pathetic remains.

Fresh Air with Closed Windows
Dr. Moore, former chief of the Weather Bureau, has not opened a window in his home for two years, and yet in the hottest weather he has a constant supply of clean, fresh, cool air. Read how he does it. Page 160.

America's Biggest Engineering Project
Guy Elliot Mitchell describes the plan for the complete subjugation of the Colorado River, an undertaking which will cost hundreds of millions of dollars, harness the horsepower from a watershed of 244,000 square miles and cause millions of acres of desert land to become productive.

MORE THAN 175 PICTURES

Complete table of contents will be found on page 216.

For Next Month

Uncle Sam—Spendthrift
We have wasted the rich natural resources of the United States. In no respect have we offended so greatly as in the ruthless way in which we have destroyed our once far-spreading forests. The story of former waste and present preservation is told by J. Bernard Walker who has made an exhaustive study of this important subject.

Uncovering Ancient Corinth
Last summer important excavations, that revealed stuccoed walls, mosaic floors and parts of a great Greek theatre of the pre-Christian city of Corinth, were carried out by the American School of Classic Studies. Dr. T. L. Shear, of Princeton University, describes the wonderful finds.

Measuring the Energy of Athletes
Professor A. V. Hill, Nobel prize winner in medicine, is studying the chemical changes which take place in an athlete's organs and muscles when in action. He uses some ingenious methods for his observations and reports surprising results.

Other articles on Coins; Fish Farming; The Super Telescope; Rust; New Arenas of Sport; New Maya Indian Finds; The Truth About Karakul; Death Valley Dates; Radio; Astronomy.

MORE THAN 175 PICTURES

¶ **Are you sure you are right? Absolutely—I read the Scientific American.**

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EINSTEIN

JUST as the Einstein theory had managed to climb into some of the most exalted circles of scientific society and was getting nicely established there, along comes Professor Dayton C. Miller with a passion for getting at the facts through experiment and offers it such a shaking challenge as it has not received in years.

Professor Miller was busy all last summer repeating the famous Michelson-Morley experiment on top of Mt. Wilson, in California, and after making more than 100,000 readings from his delicate, revolving interferometer he now announces his conviction that he has proved the existence of an ether drift. If he turns out to be right, this knocks one leg from under relativity.

After all, no matter how we feel about it, facts are facts, and the flag of science follows the truth wherever it can find it. Of course, the matter is by no means settled yet, one way or the other.

FAME

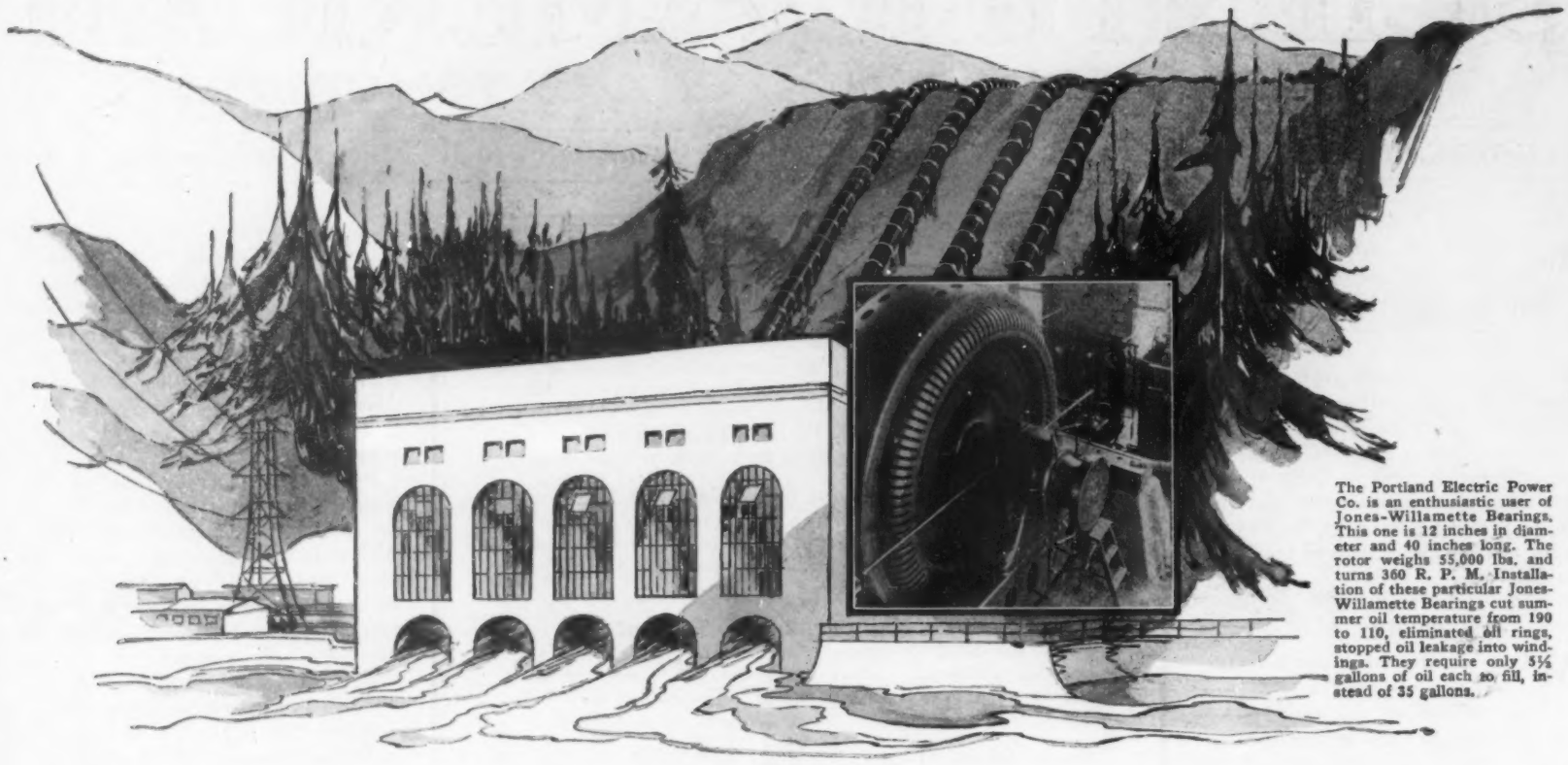
"WHEN the history of recent stellar astronomy comes to be written, some living names such as H. N. Russell, Shapley, Eddington, and Jeans will shine as stars of the first magnitude."—this is what Sir Oliver Lodge, the world's most noted scientist, says in *Nature* about Professor Henry Norris Russell, of our editorial staff.

Twenty-six years ago, an obscure graduate student from Princeton University submitted to us an article about the stars. Ever since then, with almost unbroken regularity, the same author has written a monthly article for this magazine. From obscurity, Professor Russell has passed during these years to scientific note, especially because he took the leading part in the development of the theory of stellar evolution.

We rejoice that we are still able to present to our readers a monthly review of the progress of the sciences of astronomy and astrophysics, written by so high an authority.

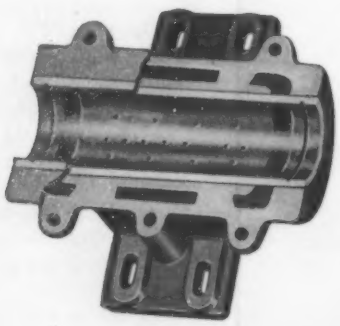
PIONEERING

BE sure to read carefully the article on the Alaska Railroad, written by its general manager. Some of you may take a trip over this line some day. If so, remember that it was built by the United States Government to develop a vast territory, that was without means of traffic communication with the outside world. From your car window the country will look very wild and few towns will be passed; but for hundreds of miles on each side of the line is a vast territory which this government railroad has placed in touch with the United States.



The Portland Electric Power Co. is an enthusiastic user of Jones-Willamette Bearings. This one is 12 inches in diameter and 40 inches long. The rotor weighs 55,000 lbs. and turns 360 R. P. M. Installation of these particular Jones-Willamette Bearings cut summer oil temperature from 190 to 110, eliminated oil rings, stopped oil leakage into windings. They require only 5½ gallons of oil each to fill, instead of 35 gallons.

New economies result in power plants after the installation of Jones-Willamette Bearings



OIL TIGHT
LESS FRICTION
LASTS LONGER

Action of shaft automatically filters and circulates oil to points of greatest load and friction. Complete lubrication means long life. Bearing completely oil sealed—oil cannot escape nor water enter.

Distributors: A few good territories are still available. Write or wire.

Jones-Willamette Bearings do not leak oil. That fact accounts for very substantial oil savings, and freedom from oil soaked windings.

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[Jones] Willamette Bearings

Pacific and Atlantic

Dr. Millikan looking into the eyepiece of the lead-sheathed electroscope with which he investigated the cosmic ray

Cosmic Rays

Radiation 10,000,000 Times the Frequency of Visible Light Has Just Been Added to the Growing Gamut of Ethereal Waves

By R. A. Millikan

Director, Norman Bridge Laboratory of Physics, California Institute

THERE has been much newspaper publicity given to the report that I made on "High Frequency Rays of Cosmic Origin" at the meeting of the National Academy of Sciences on November 9 at Madison, Wisconsin. The only official report of that address which I have submitted for publication to any journal appears in the "Proceedings of the National Academy of Sciences" for January. I wrote out hurried notes of my address for the guidance of the newspaper men who were at Madison for the sake of reporting to their various news services the proceedings, and these notes were shown to as many of the newspaper men as asked for them, but merely for the sake of guiding them in getting as correct a report as possible for their services. They were not intended as a scientific publication.

For the sake of assisting in correcting, so far as it is possible to do so by a very condensed statement, such misunderstanding as may have arisen from the reports that have gone out, I am herewith responding to the request of the editor of the Scientific American to make a very brief statement of the history of the experiments upon these rays and of the new results obtained within the past four years by I. S. Bowen, Russell M. Otis, G. Harvey Cameron, and myself.

Early Experiments on Penetrating Rays

It was as early as 1903 that the British physicists, McLennan and Rutherford, reported that the rate of leak of an entirely enclosed electroscope could be reduced as much as 30 percent by surrounding it with walls of iron or lead a couple of inches thick. This proved that the normal leak of an electroscope is due in part to rays that are able to pass through a centimeter or more of lead and then ionize the gas inside of the electroscope. The rays having this property were therefore called "the penetrating radiation of the atmosphere," and were at first assumed to be due to radio-active materials in the earth and atmosphere, and this is in fact the origin of the greater part of them.

In 1910, however, Gockel, a Swiss physicist, took up electroscopes in a balloon to a height of 13,000 feet, and reported that he found "the penetrating radiation" about as large at this altitude as at the earth's surface despite the fact that if the rays had their origin in radio-active materials in the earth and in the atmosphere they would have been expected to show a decrease with altitude. Between 1911 and 1914, Hess, another Swiss physicist, and Kolhörster, a German physicist, repeated these balloon measurements of Gockel's, Kolhörster ascending to a height of 9 kilometers, or 5.6 miles. Both men reported that they found the penetrating radiation decreasing a trifle for the first mile or so, and then increasing until it reached a value at an altitude of 9 kilometers, according to Kolhörster's measurements, eight times as great as at the surface. This seemed to indicate that the penetrating rays came from outside the earth and were therefore of some sort of cosmic origin. If so, it was computed from the Hess and Kolhörster data that the hypothetical rays would have to produce in an enclosed electroscope sent to the top of the atmosphere an ionization at least forty times as great as at the earth's surface.

Tests Ten Miles High

In 1915 I made plans to test this point by sending up electroscopes to as near the top of the atmosphere as we might hope to come, but on account of the war it was necessary to postpone further plans in this direction. In the fall of 1921, however, Mr. I. S. Bowen and myself designed, with the aid of the instrument maker, Mr. Julius Pearson, some electroscopes that we succeeded in sending up from Kelly Field, Texas, in the spring of '22 to altitudes of 15.5 kilometers, or nearly 10 miles. Our results agreed with those of the European observers in indicating a larger ionization inside our electroscopes at high altitudes than at low, but they proved conclusively that the intensity of ionization at high altitudes was not over one-fourth that which had been predicted from the Hess-Kolhörster data. This meant that the rays of cosmic origin, if they existed, were very much harder or more penetrating than the European observers had imagined, or else that the observed ionization was due to materials of some sort existing in the atmosphere itself, in which case it would presumably be of ordinary radio-active origin and hence have the absorption coefficients of ordinary gamma rays.

Accordingly, Dr. Russell Otis and myself, in the

The Truth about the Millikan Ray

A short time ago the announcement was made that a new kind of ray had been discovered by Dr. R. A. Millikan. To account for this ray, various misleading or inaccurate explanations were given publicity by the newspapers.

The editor of the Scientific American, therefore, appealed directly to Dr. Millikan himself, asking him to write out an authoritative account of his discovery. The article which appears on these pages was received in reply.

Dr. Millikan is best known to the layman scientist by his book, The Electron, in which he explains how he isolated the electron and actually "weighed" single individuals of these infinitesimally small bodies. For this research and for his work on the light-quant he received the Nobel Physics Prize. Dr. Millikan is too well known to need further introduction.

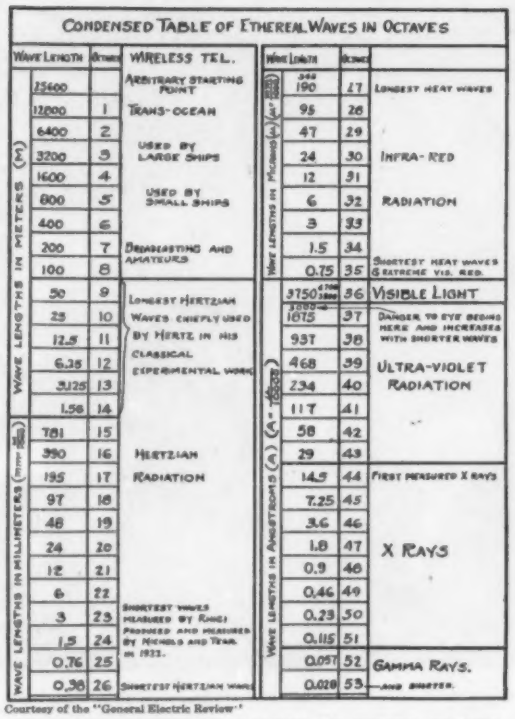
summer of 1923, carried 300 pounds of lead and a 6 x 6 x 6-foot tank of water to the top of Pike's Peak in order to find by absorption measurements what kind of penetrating power the rays existing at that altitude actually had. Our results showed that although the penetrating radiation found on Pike's Peak was about twice as strong as that found at Pasadena, the great majority of it was indeed soft radiation, no more penetrating than gamma rays of radium, and we got evidence, too, from the fact that our electroscope-leaks inside 5 centimeters of lead were reduced by a heavy snowstorm, that the penetrating rays there found were primarily of local origin.

In a word, these Pike's Peak experiments showed, like the sounding balloon experiments, that if penetrating rays of cosmic origin exist at all, it is necessary that they be very much more penetrating than any one had thus far assumed, going through such screens as we had taken to Pike's Peak without appreciable weakening, and further that they produce in our electroscopes no more than about 1 ion per cubic centimeter per second in the atmosphere at the earth's surface out of the 11 ions that we observed, and which is about the usual number observed in an electroscope at sea level. This meant that it was hopeless to attempt to obtain crucial tests as to the existence or non-existence of these hypothetical cosmic rays unless we could go to very high altitudes where the rays, if they existed, might be expected to be three times as intense as at the surface, and where we could also obtain enormously larger quantities of absorbing material than we had been able to take to the top of Pike's Peak. The only crucial test, therefore, which we could think of for the existence or non-existence of these rays, was to be found in sinking our electroscopes to various depths in snow-fed lakes situated at very great altitudes.

Rays Shoot Through Space

During the summer just past, Mr. G. Harvey Cameron and myself made somewhat elaborate preparations for making such tests, going first to Muir Lake (altitude 11,800 feet), a beautiful, very deep, snow-fed lake just under the brow of Mount Whitney, the highest peak in the United States. We sought a snow-fed lake because our own preceding under-water experiments had been vitiated by our discovery that the waters were radio-active, and we thought that that error might also have inhered in all preceding under-water experiments, and particularly in experiments in crevasses in glaciers, such as Kolhörster had recently made. The results of our summer's work were, very briefly, as follows:

At the surface of Lake Muir our electroscopes


CONDENSED TABLE OF ETHEREAL WAVES IN OCTAVES
WAVE LENGTH
OCTAVE
WIRELESS TEL.
ARBITRARY STARTING POINT
TRANS-OCEAN
USED BY LARGE SHIPS
USED BY SMALL SHIPS
BROADCASTING AND AMATEURS
LONGEST HERTZIAN WAVES CHIEFLY USED BY HERTZ IN HIS CLASSICAL EXPERIMENTAL WORK
HERTZIAN RADIATION
SHORTEST WAVES MEASURED BY RUBENS PRODUCED AND MEASURED BY NICHOLS AND TEAR, IN 1923.
SHORTEST HERTZIAN WAVE
WAVE LENGTHS IN METERS (M)
WAVE LENGTHS IN MILLIMETERS (mm)
WAVE LENGTHS IN MICRONS (μ)
WAVE LENGTHS IN ANGSTROMS (A)
LONGEST HEAT WAVES
INFRA-RED RADIATION
SHORTEST HEAT WAVES & EXTREME VIS. RED.
VISIBLE LIGHT
DANGER TO EYE BEGINS HERE AND INCREASES WITH SHORTER WAVES
ULTRA-VIOLET RADIATION
FIRST MEASURED X RAYS
X RAYS
GAMMA RAYS.
AND SHORTER.

Courtesy of the "General Electric Review"

THE ENTIRE KNOWN GAMUT OF ETHER WAVES

Thanks to Dr. Millikan, the following data must now be added under the right-hand column: "0.0004 A to 0.00067 A—Cosmic or Millikan Rays"

showed a rate of discharge corresponding to 12.4 ions per centimeter per second. *As we sank the electroscope to greater and greater depths this rate of discharge decreased continuously down to a depth of 50 feet, after which it became constant at a value of 3.4 ions per cubic centimeter per second.* No preceding under-water experiments had revealed a decrease in ionization below the value found at the surface more than about a fifth or a sixth part of that here found. This meant that we had obtained much more unambiguous and thoroughly quantitative evidence than had before been available for the existence of an extraordinarily penetrating radiation, indeed, so hard that, if it came from outside the atmosphere, it required 50 + 23, or 73 feet of water, the equivalent of more than 6 feet of lead, to absorb it entirely. The 23 feet in the foregoing is the water equivalent, so far as absorption is concerned, of the atmosphere above Muir Lake. How uncertain has been the evidence heretofore is well shown by the fact that one of the most careful and reliable of the German physicists, Hoffman, has just published a paper in November, 1925, in which he thinks he proves that these hard rays do not exist at all, the results all being accounted for by radio-active impurities.

To get crucial tests as to whether the hard rays here observed were of cosmic origin or not, we next went to another very deep snow-fed lake, Lake Arrowhead, in the San Bernardino Mountains, 300 miles farther south, which has an elevation of 5,125 feet, and where the Arrowhead Development Company put all their conveniences at our disposal. The atmosphere between the two elevations of Lake Muir and Lake Arrowhead has an absorbing power for any very penetrating rays equal to about 6 feet of water. If the rays that we observed at Muir Lake all came in from above and if there were no rays at all generated in the atmosphere between the two lakes, we expected to find that each electroscope reading at a given depth below the surface in Arrowhead Lake would be the same as the reading at a depth 6 feet farther down in Lake Muir, the atmosphere between acting merely as an absorbing screen, and *as a matter of fact in both our electroscopes we did find this prediction very beautifully verified.* Our proof, therefore, is now quite definite and unambiguous that there is an extraordinarily hard radiation coming into our atmosphere from outer space. Further, *since at all the altitudes at which we have experimented we find no measurable variation in the intensity of these rays at any time between midday and midnight, we conclude that these rays shoot through space equally in all directions.*

A Wavelength of .0004 Angstroms

By the use of a formula of probable, though not of certain reliability, we can translate the observed absorption coefficients into frequencies or into the inverse of frequencies, namely, wavelengths. By so doing, we find that our hardest observed rays, those which our curve of variation of electroscope-leak with depth in water shows to have an absorption coefficient of .18 per meter of water, have a wavelength of .0004 A. This corresponds to a frequency at least fifty times that of the hardest gamma ray, a thousand times that of the average X ray, and about ten million times that of ordinary light.

Our experiments further showed that these rays of cosmic origin are hardened as they go through the atmosphere, just as X rays are hardened in going through lead, and thus *we infer that we are working with a region of spectral frequencies about an octave in width and ten million times above the octave of optical frequencies to which our eyes respond.*

This is a condensed statement of the facts about cosmic rays which the work of Mr. Julius Pearson, Mr. I. S. Bowen, Mr. Russell Otis, Mr. G. Harvey Cameron, and myself have brought to light within the past four years.

Brown Brothers

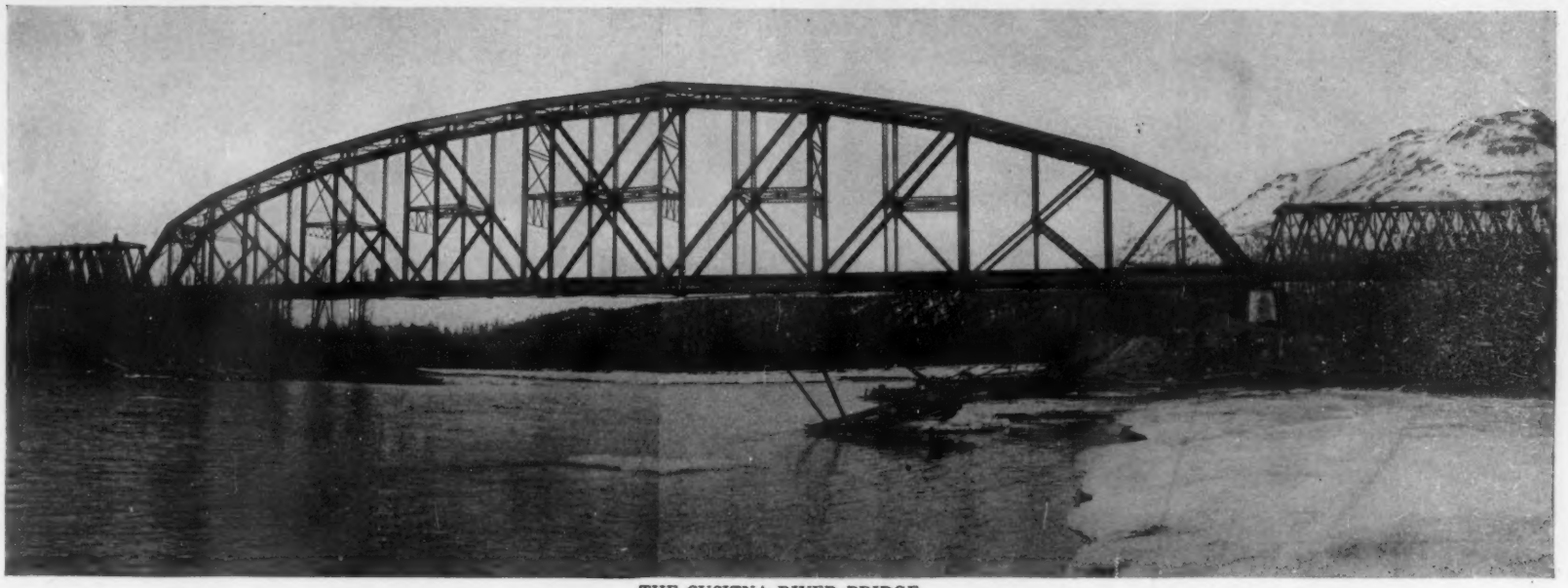
THE ELECTROSCOPE, A SIMPLE INSTRUMENT FOR MEASURING ELECTRIC CHARGES

As the charge leaks off, the two little strips of gold leaf fall together. X rays, cosmic rays and other rays discharge the electroscope at a measurable rate

Brown Brothers

X RAYS DISCHARGING AN ELECTROSCOPE AT THE DEPARTMENT OF PHYSICS, NEW YORK UNIVERSITY

Were this electroscope sheathed in lead, the X rays would be excluded. The cosmic rays, however, penetrate even the lead, discharging the electroscope



THE SUSITNA RIVER BRIDGE
This fine steel span, 504 feet long by 40 feet deep, 265 miles from the coast

Our Alaska Railroad

How the Building of This Railroad in the Face of Colossal Obstacles Opened the Far North to Freight and Passenger Traffic

By Noel W. Smith, General Manager

THE object for which the great task of building the Alaskan Railroad was undertaken and carried to completion in the face of colossal obstacles in an almost uninhabited country was not for the development of the country that can be seen from the car window, but for the development of a vast area hundreds of miles from the rails.

Viewing the broad field for development, the cost to the Government, after two years of actual placing in operation of a standard-gage line, above the earnings received, is of little importance. This deficiency, however, looms large in the minds of some people who have not traveled far beyond the line of the road and who appear to have overlooked the fact that our Government, by land grants, made possible the construction of our transcontinental railroads.

The railroad is operated continuously every month in the year. Though the amount of freight and number of passengers handled during the winter are small, it is important for the proper development of the service that such service should be performed. The roads so far constructed in Alaska are not hard surface roads. They are built by covering the grade with gravel and are suitable only for wagons, automobiles and light trucks. Only when the grades of these roads are frozen, can very heavy loads be hauled over them. Mining machinery, coal, oil, ore and similar commodities can be more economically transported in the winter season for this reason. In fact, heavy loads can not be transported at all when the roads are not frozen. In some locations no summer roads exist—there are no bridges built over streams, lakes and swamps which can be safely crossed when frozen. Certain lumber operations can be conducted in the winter better than in the summer, as is the case in all such operations. All winter activities can be more economically performed and, therefore, the development of the country advanced, if the railroad is in operation.

CONSTRUCTION DETAILS OF THE BRIDGE
View looking through the 504-foot span showing the impressive end portal, and the overhead sway bracing

Operates All the Year Round

The morale of the railroad employees, as well as that of all other winter residents, is improved by reason of being in constant touch with the outside world, being able to get their mail and to travel back and forth.

The Alaska Railroad extends from Seward, an open port on the Gulf of Alaska, to Fairbanks, 470 miles northward, connecting at Nenana, 411 miles from Seward, with the interior river system.

The term "open port" may need some explanation. Contrary to what would be supposed and to the usual impression, Seward and other ports on the Gulf of Alaska are open to vessels every month in the year and the difficulties in docking vessels because of interference from ice are practically negligible, less than those experienced at Baltimore or Philadelphia.

The Alaska Railroad is operated every month of the year. The climate varies as to temperature and snow fall on different sections of the line; but only on two sections, namely, where the line crosses the Chugach Mountains, which are parallel to the Coast, and the Alaska Range, which is the divide between the drainage area to the Gulf of Alaska and the Yukon basis, are rotary snow plows necessary to keep the road open.

There are two important branches, the Chickaloon Branch from Matanuska to Chickaloon, 37.7 miles, from which there are three spur tracks to the coal mines, and the Chatanika Branch, which is a narrow-gage line and a part of the old Tanana Valley Railroad. This branch passes through the placer gold fields of the Fairbanks District. There is also a four-mile spur track from Healy to the mines of the Healy River Coal Corporation. It will be noted that the main line of the railroad is approximately the same length as the Pennsylvania Railroad between Chicago and Pittsburgh.

The road runs in a general northerly direction from Seward on to the Gulf of Alaska to Fairbanks,

CROSSING THE RIVERS
Much of the work was necessarily of a temporary character. Hence timber trusses and pile trestles were used

Courtesy of Alaska Moving Pictures Corporation

ALASKA CANNOT DAUNT THE MOVIE MAN

The "movie man" is ubiquitous. Here we see the train of a large moving picture corporation filming gold rush scenes amid the eternal snows of the Cheechakos

CANYONS CANNOT STOP THE BRIDGE BUILDER

Although many of the lesser structures on the line are of timber, the more important structures, such as this fine trussed arch bridge, are of steel

a distance of 470 miles; and it has to overcome two mountain ranges, one not very far from the coast and running approximately parallel thereto, the other and higher range being the continental divide. Leaving Seward, the line climbs the Chugach Mountains above mentioned, on a grade of 2.2 feet in each hundred feet, to Divide, which is twelve miles from Seward. After a short descent on the same grade, the run is on an easy grade to a point 40 miles from Seward where it again climbs the mountain, on a grade two feet in a hundred, to the summit at Grand View where the elevation is 1,063 feet. From the summit, the line falls on a grade of 2.2 feet to the hundred to the southern end of Turnagain Arm of Cook Inlet. Because of the steep slopes of the mountain and for other topographical reasons, it was necessary, in order to keep the grade from becoming too steep, to build a loop which is recognized as being a fine example of engineering skill. From mile 60, the line runs on an easy grade to Anchorage, 114 miles from Seward.

Forms Link with United States

Anchorage is the railroad headquarters, and the repair shops are located there. The relation between Seward and Anchorage is not unlike the relation between New York and Philadelphia. Both are seaports; but Seward is an open port almost directly on the Gulf of Alaska, while Anchorage can be reached by water only after a long journey on Cook Inlet. Moreover, ice conditions permit the operations of vessels to Anchorage but seven months of the year.

From Anchorage the railroad passes through the valley of the Susitna River and follows the headwaters of that river, crossing the Alaska Range, which is the continental divide of Alaska, through the Broad Pass.

The summit, 310 miles from the coast, is the highest point on the line, with an elevation of 2,364 feet. The maximum grade encountered is one of 1.75 feet in one hundred feet. From the summit the railroad follows the headwaters of the Nenana River and the river itself to Nenana, where the Tanana River is crossed. Between Nenana and Fairbanks, 470 miles from Seward, the railroad, while it is parallel to the Tanana River, is in the valley of Gold Stream. The elevation of Nenana is 362 feet, and of Fairbanks, 448 feet.

At Nenana, connection is made with river boat service on the Tanana and Yukon rivers; at Fairbanks, with a narrow gage; from the Chatanika Branch, to the gold fields by road and trail. Outlying points are reached by roads and trails. Airplanes are also available for commercial flying to points in the interior to which access is difficult by ordinary means of travel.

The true position of the Alaska Railroad in the field of transportation is often overlooked by those who visit Alaska and after superficial inspection give their views and impressions of Alaska. The railroad is sometimes described as connecting the city of Seward, with a population of about 1,000 people, with the city of Fairbanks, with a population of about 2,500 people, passing through Anchorage, a railroad city, and a sparsely populated intervening country. The impression conveyed is that the purpose of the railroad is to furnish transportation between these small cities.

As a matter of fact, the railroad is a connecting link between the transportation system of the United States, through the port of Seattle, by means of steamships plying between Seattle and Seward, and the vast interior of Alaska.

Fairbanks, from a traffic standpoint, is not a small city but a large mining district, served by a narrow-gage railroad, by roads and trails. Supplies for this district, while they are shipped chiefly from Seattle and Pacific Coast points, come from all parts of the United States; and the gold produced adds to the wealth of the nation. Without the railroad, few, if any, of the activities of the district could be carried on.

CURVING THROUGH A ROCK CUT

The survey for the line follows the windings of the river valleys, and many rock cuts had to be made, as here, through the projecting bluffs

Nenana is the junction of the railroad and the interior rivers. The Alaska Railroad operates steamboats between Nenana and Holy Cross on the Yukon River for a distance of 720 miles, taking in supplies, bringing out products and carrying passengers, not only for the country along the river but for points on down the river. These products and passengers are subsequently transported by small boats and the vessels of the Northern Commercial Company to St. Michael, Nome, the Iditarod country, points on the Koyukuk River, and to other tributary country by the use of roads and trails.

Earnings Gradually Increasing

The American Yukon Navigation Company operates steamboats between Dawson and Nenana. These boats connect by steamboat service between Dawson and White Horse, and by the White Pass and Yukon Railroad between White Horse and Skagway, and with steamship service between that point and Vancouver and Seattle. Ore concentrates from the Stewart River country are delivered to the railroad via this route for transportation to the States for smelting. Oil and gasoline are the principal inbound shipments via this route, but other supplies in small quantities are moved. It is a popular tourist route; but it is limited by difficulties in obtaining outbound passage from Seward. From various points along the line, roads and trails connect vast areas, some of them producing, others, in the process of development or exploration, giving promise of becoming important producing fields in the future. Additional roads and trails as well as the extension of the present ones are needed for the development of these and similar fields.

The operations of the railroad, like other Government departments, are conducted on a fiscal year basis. The earnings for the rail line, not including the river boat service, for the fiscal year 1924 were $907,174; expenses, $2,643,750; deficit, $1,736,576; the earnings for the fiscal year 1925 were $797,440; expenses, $2,324,155; deficit, $1,526,715. Included in the deficit shown for the fiscal year 1925 is the $280,040 charged to expenses on account of replacement of bridges and trestles, making the charges to actual maintenance and operating expenses $1,246,-

675. This charge was due to charging the expense portion of roadway and equipment expenditure to expenses in accordance with Interstate Commerce Commission rules, which was not the practice in 1924. Therefore, the operation costs of the road were decreased approximately half a million dollars in the year 1925.

It will be noted that the earnings also decreased; but the showing is quite satisfactory when it is explained that the decrease was due to the discontinuing of certain activities of the railroad which produced gross revenue but which were conducted at a loss, and because of a temporary decrease in the shipment of ore concentrates.

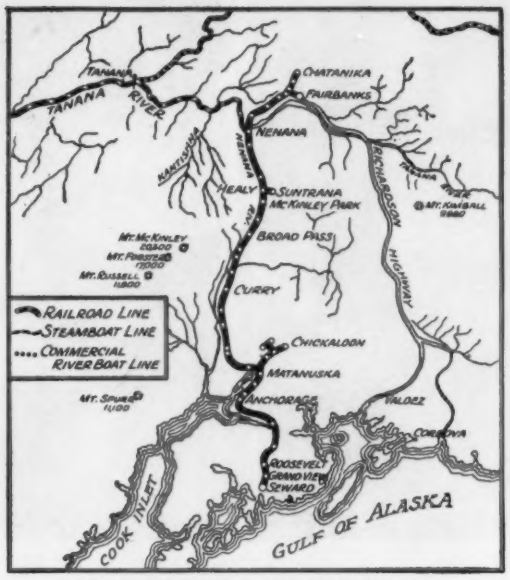
It will be observed that the trend of traffic is upward and therefore encouraging. Viewing the situation by comparison with that of a year ago, it is even more so.

Alaska's Resources Now Better Understood

There is a much better understanding of the value of the mineral and other resources, their limitations and the proper method of procedure for development. Much harm has been done to Alaska by extravagant and exaggerated statements as to the wealth of its resources on the one hand and by incorrect statements on the other as to the lack of value of its resources. It is now realized to a much greater extent than ever before that Alaska has resources; but, like any other country, hard work and ample capital are needed for their development. This capital is now welcome, while formerly any offers of financial assistance were looked upon with suspicion.

The maintenance of way and structures expense offers the greatest field for reduction in expenses, due to the unfinished conditions and number of temporary structures. The members of the Alaskan Engineering Commission had to contend with the most serious difficulties in locating and building a line of railroad through the wilderness. Knowledge was lacking on many important matters. Too great praise can not be given the Commission for the accomplishment of this project in the face of a good many obstacles.

Prior to the authorization of the construction of the Alaska Railroad, the Alaska Northern Railroad had been built northward from Seward for a distance of 71 miles, but was not a financial success. This railroad was purchased by the Government but had to be rehabilitated and in part reconstructed. The Tanana Valley Railroad, a narrow-gage line, had been built from Fairbanks to Chena and to



MAP OF THE ALASKA RAILROAD

The length of this Government railroad, from Seward on the Gulf of Alaska to Fairbanks, is 470 miles

Chatanika. River boat traffic for Fairbanks was handled at Chena because the depth of water in the Chena Slough at Fairbanks is not sufficient to allow steamboats to come to Fairbanks, except in periods of high water. The Tanana Railroad was also purchased by the Government and construction was undertaken from the Seward end of the line northward.

The necessity for pushing the ends of steel on each of the sections in the short working season made it imperative that every expedient for advancing the work be used. Embankments in many instances were not raised to the adopted profile; a limited amount of ballast was placed under the ties; trestles built of spruce cut along the line were built where such construction would save time; and bridges, with few exceptions, were built on pile foundations, much of the piling being of native spruce.

In many cases, due to the frozen condition of the ground and other reasons, the penetration of the piles was extremely small. Cuts and fills in many cases were not made as wide as desirable and bank protection was deferred until the line was connected through. Until these conditions can be corrected, the cost of maintenance must be high. The life of the native spruce piles is found to be short and heavy renewal, or replacement, is now becoming due. As rapidly as funds are available, these bridges and trestles are being replaced by steel, concrete or solid fills with necessary culverts. Banks and cuts are being widened and additional ballast is being placed under the ties. As these improvements progress, the cost of maintenance will proportionately decrease.

Economies are also possible with more modern and up-to-date rolling and floating equipment, by the use of hydroelectric power for power and light, and by the expenditure of money for improvements of various kinds.

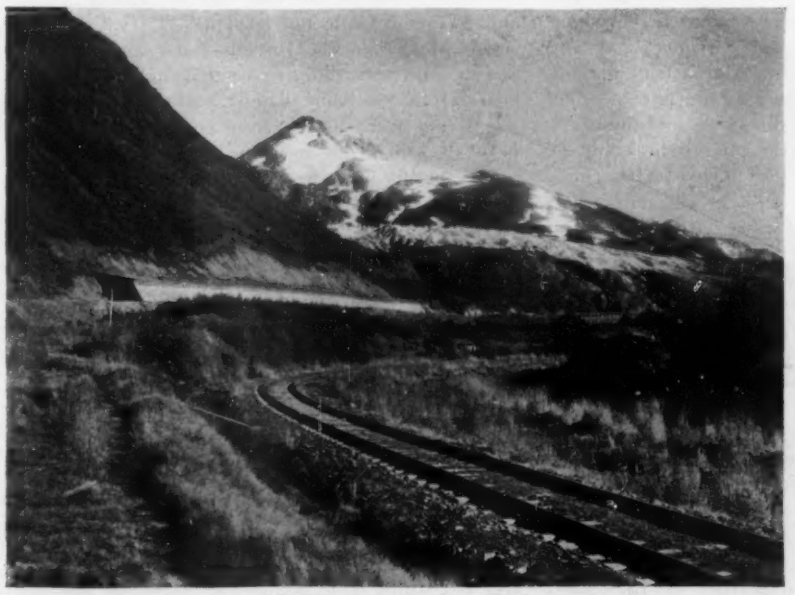
In placer mining, the small mines are passing, but large dredging operations have subsequently taken their place.

Load mining has been neglected in the past, because the old-time Alaska miner was a placer miner; but it is receiving much attention now. A gratifying advance was made this year in this field, the greatest progress being made in the Willow Creek district, which is about 160 miles by rail north of the city of Seward.

Should Eventually Be Self-supporting

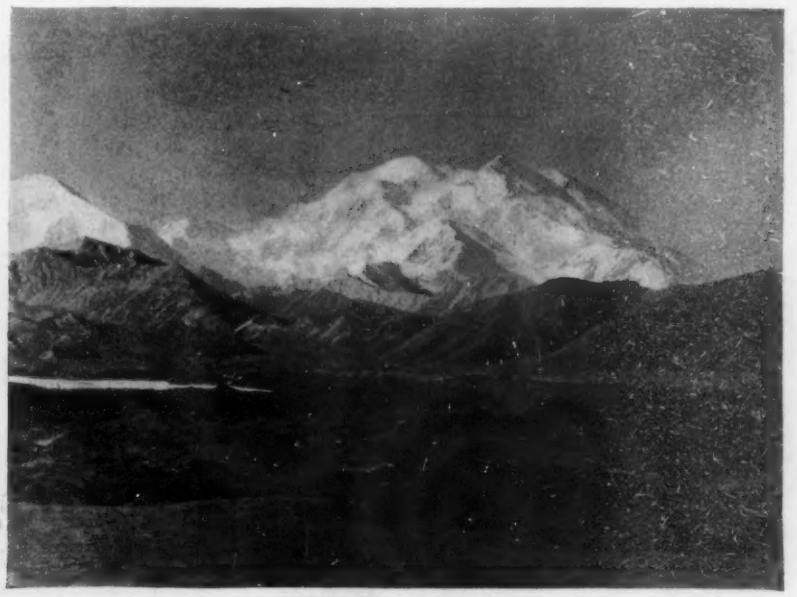
The coal mines have been improved and a new mine, the owners of which are possessed of ample capital, has been opened. Alaska coal has been praised by many and condemned by others and has frequently been described in a manner that would indicate that there is but one kind of coal. All kinds of coal are mined in Alaska, from very recent lignite to anthracite. Lignite of a very good quality and bituminous are mined commercially. Cannel coal and blacksmith coal are mined in small amounts. About half of the commercial tonnage of the railroad is coal for domestic use, power plants and dredges. A small quantity is used along the Alaska coast, especially by canneries, and such use should increase materially as the cost of production decreases.

Lumber operations and fur farming show gratifying increases over last season, and agriculture and other activities, a slight increase. Tourists are coming to Alaska in increasing numbers, as well as large game hunters. The prospects are favorable for a steady growth in traffic on the Alaska Railroad which, coupled with decreased maintenance and other costs resulting from improvements, should eventually make it self-supporting. Such a situation, however, can not come about immediately, and should not be looked upon as the fulfillment of the purpose of the railroad.



IN THE MOUNTAIN RANGE

In the foreground is the main track, in the middle distance is a stretch of snowshed, and in the background, a glacier and mountain peak



THE GLORY OF ALASKA

A high, snow-capped mountain peak. The scenic setting of the Alaska Railroad matches the Alps or the Rocky Mountains in splendor

UNCOVERING THE FIRST OF THE COFFINS

These coffins were in a poor state of preservation and yielded only a single cross. The actual labor of excavation was performed by Eskimos

BURIED UNDER AN ANCIENT CHURCH

Pressure due to the earth above had caused the lid of this wooden coffin to collapse. All that remained of its contents was a large, rude cross of wood

Solving Greenland's Historic Mystery

The Medieval Tragedy of White Colonists in the Far North

By Harold J. Shepstone, F.R.G.S.

THE excavations carried out by Dr. Poul Norlund of the National Museum, Copenhagen, at Herjolfsnes, the old Norse settlement of Osterbygd, in the present district of Julianehaab, in Southern Greenland, throw interesting light upon the mysterious fate of the early Norse settlers in this land of the Far North.

In the ancient churchyard at Herjolfsnes, some two hundred valuable relics were found. Many coffins were unearthed, as well as skeletons of the old Vikings in their shrouds, well-preserved articles of clothing, implements, tools, ornaments, and an imposing array of Christian crosses.

Early in the summer of 1921, Dr. Norlund and his party landed in Greenland. After examining the ruins of various Norse settlements they proceeded to Herjolfsnes. At first, inclement weather and the ice hindered their movements. It was not until the beginning of July that the work of excavating was begun. This work continued without a break until August 27th, when attention had to be given to the packing of the many relics that had been found. On account of their age and the delicate nature of many of the finds, particularly the garments, it was most essential that they should be handled carefully.

When they finally arrived at the museum in Copenhagen they had to be examined and classified. This work occupied considerable time, but the result has now been embodied in a bulky volume, *Meddelelser om Grönland (Communications on Greenland)*, which scholars of the future will regard as an important archaeological contribution concerning the fate of those hardy Norsemen who settled in Greenland in the early centuries of the present era.

Herjolfsnes, the scene of the excavations, is a barren, bleak spot, at the foot of Ikigait, an imposing headland, directly on the seashore and destitute of any habitation. The only signs of life the excavators found when they rowed ashore were the wild ravens that circled above them, declaring loudly their displeasure at being disturbed. Herjolfsnes was founded by an Icelander, Herjolf Baardson, who followed Eric the Red to Greenland in about the year 986. It was Eric the Red who discovered and first colonized Greenland, and for a period of 250 years Greenland was an independent state. Then it came under the sway of the King of Norway.

By the Twelfth Century the population of the Greenland colonies could not have numbered less than three thousand. They boasted of their cathedral, monasteries, fourteen churches and 240 large farms. A brisk trade was maintained with Europe until towards the end of the Thirteenth Century when it began to decline, and by the Fifteenth Century it had ceased altogether. It is common knowledge that when Hans Egede, the Danish Lutheran clergyman, went there in 1721, he found only savage, nomadic Eskimos, and from that time up to the present day historians have argued over the fate of the early white settlers.

Sea Uncovers Coffin

The very location of Herjolfsnes was lost. Its site was not rediscovered until 1830 when a missionary visiting the region found an inscribed tombstone used as a capstone over the door of an Eskimo hut. A few years later, as the result of the encroachment of the sea at this spot, a coffin was uncovered, and a Danish official, Ove Kielsen, after a trial digging lasting two days, definitely located the ancient cemetery. Several coffins were found, in addition to a skull with the hair preserved, the light color of which proved definitely that the buried bodies could not be those of Eskimos.

Every time the sea carried away part of the shore, fresh burial remains came to light. This led the Danish Commission, a body responsible for the scientific exploration of Greenland, to open up negotiations with the National Museum in Copenhagen for a technical excavation of the churchyard site.

It was not easy at first to locate the exact site of the churchyard, for the ruins were found to be almost completely overgrown with grass and furtle, only a few stones peeping out here and there. The first task of the excavators was a series of draining operations. This precautionary work proved invaluable in keeping out the water.

It took some days before the yielding layers were reached, but, when the first difficulties had been overcome, the finds came in rapid succession. On July 8th, a wooden cross was unearthed and on July 9th, the first coffin, and on the 11th, the first costume. "The special conditions of the excavations," writes Dr. Norlund, "necessitated the invention of special methods for the exhumation and conserving of the finds, particularly the woven materials. They all lay directly in the earth and would hardly bear touching in their saturated, recently thawed condition. Sometimes the earth could be rinsed away, sometimes it had to be removed with a shovel. In certain cases the uncovering of a costume took a whole day's persistent work. The costume, once uncovered, had to be taken up, and that was an even more difficult task. The wet material was just as heavy as it was frail and could not carry its own weight. It was necessary to unroll sacking under it.

"The next difficulty was the keeping of the costumes. It was the middle of summer and not until the autumn, several months hence, could we expect to be in Copenhagen. There could be no question of any actual conservation on the spot. I tried to clean the earth off the material by rinsing it thoroughly, but it could not be done. I tried drying it slowly, but then the threads burst and crumbled away. The only thing to be done was to keep the material in the same damp condition in which it was found and guard it from contact until it could be dealt with at the museum at Copenhagen.

"We had brought with us three large, tin boxes in which we had intended to deposit the finds for fear the saliferous humidity of the ship's hold should affect them. But, with objects of this kind and in this condition, humidity would be no danger. Apart from the fact that the tin boxes could not hold the very numerous objects, they proved quite unsuitable. A few pieces of cloth kept therein became mildewed.

"The tin boxes being useless, we had to send to the nearest settlement for boards from which we made up cases adapted to the size of the costumes. But how were we to pack them so that they lay firm and would not dry? We had to deal not only with the costumes but with the numerous wooden objects that came to light. It was a serious problem. Grass, heather and seaweed were found to be unsuitable. Our difficulties were fortunately solved in the most satisfactory way. The beds of the numerous little rivers, carrying the melted snow down the mountain-

side, were overgrown with thick, quite saturated moss.

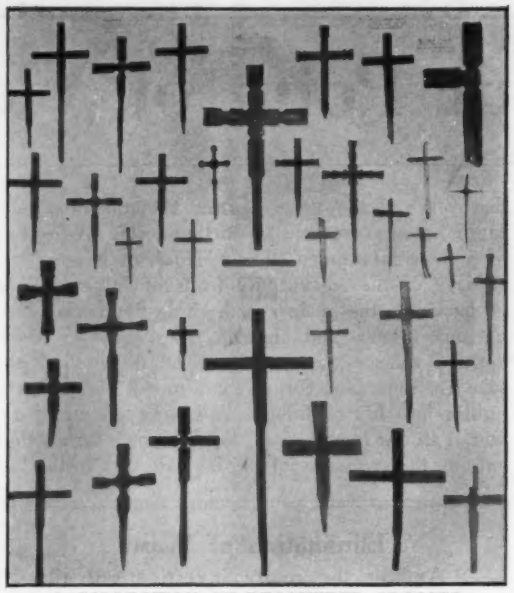
This moss possessed all the properties we required. It was firm, yet soft, and very slow-drying and it was present in almost unlimited quantities. When the objects were temporarily laid on the grass, we covered them with it, and later on we used it as a packing material in the cases, where it lay firmly pressed down on the objects and kept them damp without preventing the access of air. Thanks to this, on unpacking, we found all the objects in exactly the same conditions in which they were laid down, despite the fact that three months had passed since the dispatch of the cases from Herjolfsnes."

Twenty-nine coffins were exhumed, but they did not yield so much as a shroud or even a piece of bone, being simply full of earth. Yet it was in the coffins that the more valuable crosses were found where they had been laid on the breasts of the dead. They are perhaps the most interesting part of the grave furniture, the collection totalling over fifty. Some are elaborately carved and inscribed with the name of the deceased and some religious quotation. In one coffin was found a little, carved stick with the following inscription in the Norse tongue: "This woman, whose name was Gudvig, was laid overboard in the Greenland Sea," the inference being that she died on the way to Greenland, was buried at sea, and on arrival of the vessel at Herjolfsnes the little stick was carved in memory of her, placed in a coffin, and buried in the churchyard.

Coffin-burial a Luxury

The coffins were mainly of spruce, deal, red pine or larch and consisted of drift and imported timber. Only a single specimen was found to be of native growth, namely, of Juniper wood, a tree which still flourishes in Southern Greenland, although inclined to be stunted in growth. Some of the coffins were joined by wodden nails, others by whalebone fiber.

The distribution of the coffins and shrouds would indicate that coffin-burial was preferred by those who could afford it. For the most part the coffins were found closely packed around the walls of the church where the most coveted burial-places were. In the out-of-the-way corners of the churchyard there were no coffins, but here some of the best-preserved shrouds were found. These shrouds consisted of genuine articles of clothing, sometimes complete, sometimes mere fragments, but rarely so fragmentary that their use could not be determined. There were dresses, hose, hoods and caps. Evidently the clothing was not made for the dead, but had been worn by them when still alive. Hence they bear



A COLLECTION OF RECOVERED CROSSES

Altogether, fifty-eight of these wooden crosses, some of them bearing runic inscriptions, were dug up

marks of wear, and indeed, many of them are quite threadbare and patched with big patches. Mending was done by means of patching, darning as a means of repairing evidently being unknown. All the costumes are of woven material and from tests made, they would appear to be entirely of sheep's wool.

It was only in the shrouds that any skeletons were found and some twenty-five of these were brought to Copenhagen. They were in a poor and exceedingly fragmentary condition and at first appeared to be hopelessly damaged and devoid of any value. Thanks to the skill and initiative of Dr. C. C. Hansen, Professor of Anatomy at the museum, they were cleansed, sorted and subjected to minute microscopical examination with the most interesting results.

The task of conserving the relics was a protracted one. It also proved troublesome, and was inclined sometimes to be rather unpleasant. The wooden objects were treated with alum or glycerine. The various articles of clothing were first immersed in water, lying on the sacking on which they had been taken up. Here they remained for some days in order to dissolve the various foreign substances that had become entangled among the threads, such as root-fibers, and especially deposits from the decayed body clinging to the material.

After the rinsing was finished the stuff was slowly dried, and was then subjected to a kind of massage cure, being laid on a table and treated with the fingertips to remove all foreign particles. This was the most important part of the conservation work, and also the most troublesome part. But when it was accomplished, the material had regained its old elasticity, and, to an astonishing degree, its original strength. A backing of tulle was affixed to the more dilapidated parts, whereupon all the material was treated with a beticol preparation.

The style and cut of many of the costumes would indicate that they are of the Fourteenth and Fifteenth Centuries, clearly showing that the Norsemen were in communication with Europe up to that time. There is certainly geographical and geological evidence to show that it was at this period that a fatal change of climate occurred in these northern latitudes. Whereas Herjolfsnes and the adjoining fjords had been free of ice all through the summer, they suddenly became blocked virtually all through the year, thus rendering navigation exceedingly precarious if not impossible.

It was at this period, too, that a gradual decline of shipping in Norway took place. This decline of shipping, coupled with the unexpected presence of ice in midsummer, no doubt meant that attempts to keep in touch with the settlements were gradually given up and then ceased altogether.

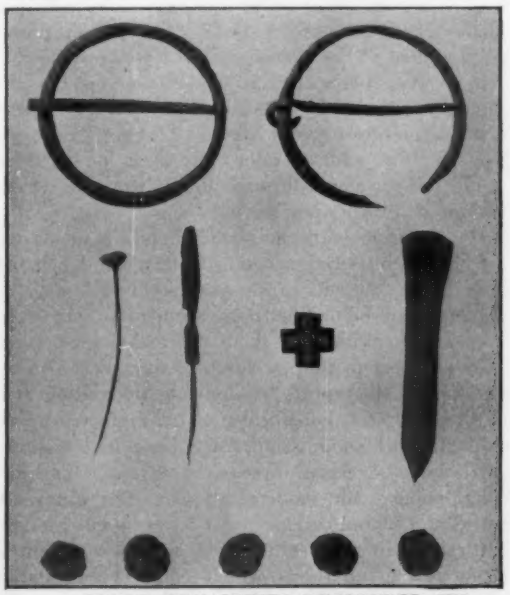
When the Norsemen settled in Greenland there were no Eskimos there, although they found remains of Eskimo dwellings. The latter had retreated northward following the ice on which they hunted seals, their principal item of food. Much later, when the ice came south, they poured down upon the colonists and there are records of encounters between them.

Ravaged by Disease and Malnutrition

Being cut off from Europe, on which they had learned to depend for many essentials to their existence, and being called upon to face a terribly rigorous and hard climate, the colonists gradually deteriorated in physique. This is evidenced by an examination of the skeletons. They were short of stature, especially the women. Constitutionally they were a weak and declining race, due no doubt to a long period of undernourishment.

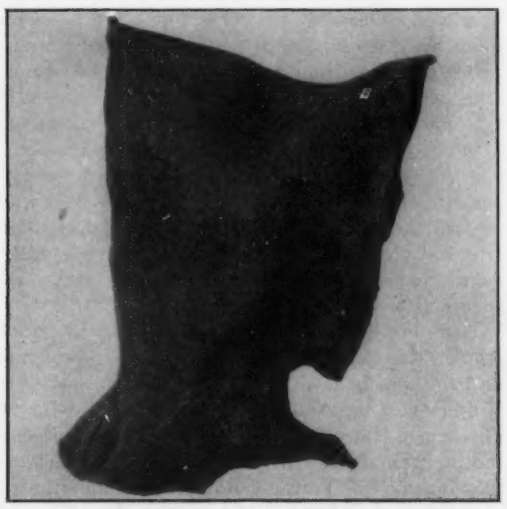
Not only were they small of stature but, from an examination of the skeletons, many of them had diseases involving physical deformities such as the weakening of one arm, or one leg, and even in some cases the trunk of the body. There are also distinct traces of tuberculosis of the vertebral column.

Against the Eskimos, so brilliantly adapted to the arctic conditions, the physically weakened Norsemen could not hold out and their doom was sealed by the encroaching Greenland ice.



CRUDE ORNAMENTS RECOVERED

Two brass brooches, copper pins, a pendant cross of bone, a wooden peg and a man's sleeve buttons



AN ANCIENT HOOD

Skulls of both men and women were found inside hoods made of coarsely woven material

THREE GENERATIONS

A man's short-sleeved dress of heavy material, a child's dress and that of an older girl

Our Point of View

The Last Word on the *Shenandoah*

AFTER a most searching investigation into the loss of the *Shenandoah*, the court has issued a report which we think should carry conviction. Anyone who followed the long-drawn-out hearing must have shared our conviction that no partiality was shown and that the court was honestly striving to get at the absolute facts. In the first place, the court places no blame upon any of the personnel for the loss of the *Shenandoah*. It was clearly established that the naval authorities at Washington, so far from forcing the hand of the late commander, Landsdowne, listened to his objections against making the trip earlier in the season, as first proposed, and left it to his final decision as to when it would be desirable to start on the trip to the west. It was clearly established that not only the captain but all of the officers and crew, entered upon this cruise not only free from apprehension, but with the enthusiasm which is characteristic of the flying personnel. The disgusting newspaper sensationalism (we can call it nothing less), which did not hesitate to invade the privacy of a young widow within a few hours after the death of her husband and endeavor to show that there was coercion on the part of the Government, was proved to be sensationalism pure and simple without a basis of fact for its charges.

It will be no surprise to those who followed the evidence that the court exonerates the personnel from any responsibility for the disaster. The loss of the *Shenandoah* must be considered "as part of the price that must inevitably be paid in the development of any new and hazardous art." As we suggested in an earlier issue, it was the entrance of the ship into a violent line storm with its ascending and descending currents which destroyed her. "The final destruction of the ship was due primarily to large, unbalanced, external, aerodynamic forces, arising from high-velocity currents."

Although the court holds that none of the structural changes in the ship contributed to the accident, it gives a measure of endorsement to the claim made by Captain Heinen that the reduction in the number of gas valves was the direct cause of the accident. A review of the testimony on this point, says the report, justifies the opinion that "gas pressure due to altitude and rate of rise may well have reached values sufficiently high to produce damage to the structure." We believe that, though excessive gas pressure and aerodynamic forces had their share in the destruction of the ship, it will never be possible to determine the relative destructive effect of each.

Billion-Dollar Dividends of Research

IN a recent address, Secretary Hoover pointed out to the American nation that our material civilization rests squarely on the sub-foundation of abstract research in pure science. When you telephone, when you drive your car, when you wash with scientifically made soap or eat scientifically balanced bread, do you think of the ultimate source of the scientific truths that made them possible? Just as engineering, industry, medicine and all the important arts of today rest on fundamental scientific principles, doggedly worked out in the past, so those of the future will depend on the research of today.

Professor R. A. Millikan recently pointed out that our entire knowledge of mechanics rests on the abstract research of one man, the immortal Galileo. In our own day one man's research resulted in the discovery of the three-element vacuum tube, and radio became possible—a billion-dollar by-product of a mere laboratory effort. Think of it!

More of the current dividends of industry must go back into the business, enriching the mother lode of pure science and abstract research from which applied science may later on be dug. And the scientist must not forget that, unless he take the public into his confidence and write about his research in the language of the ordinary mortal, thus gaining the sympathy of the layman, who in the last analysis foots the bill, his beloved science will always be in danger of such attacks as that which occurred last summer in Tennessee.

Elimination of Waste

Among the many investigations that are afoot, and their name is legion, there is none so rich with promise of benefit, industrial, financial, aye, and social, too, as that which is being carried on under our indefatigable Secretary of Commerce, Herbert Hoover. We refer to the nation-wide campaign to eliminate waste. Already the first fruits have been gathered. There has been an increase in railroad efficiency; larger and faster trains carry freight at a markedly lower cost of fuel per ton-mile. By improving inland waterways, bulky goods are being attracted in the midwest area to the cheaper water-borne traffic. There is a fuller utilization of our water resources for irrigation, flood control and power. There is an ever-increasing elimination of waste, by closing innumerable small power plants and concentrating in highly efficient units in a few large stations. Let us never forget that failure to use great natural resources is waste on a gigantic scale. Neglect of water power means an equivalent consumption of coal, and coal thus used is coal wasted.

Physicians and Philanthropy

WHATEVER may be said against the superior social standing, which is still accorded in many European countries to the professions as distinguished from the trades, the distinction, where it exists, is based upon a historical fact of great ethical interest. Centuries ago, when learning was confined almost exclusively to the doctor, the priest and the lawyer, and the great mass of the people, from lordly baron down to poorest serf, were absolutely unlettered, it is a well-attested fact that these gentlemen were supposed to give and very largely did give their services gratis, their remuneration depending upon the means and good-will of their clients.

That this high, ethical standard is by no means dead in this money-making age is proved by certain statistics which have recently been made public by a director of the National Endowment Fund for the Physicians' Home for Aged Physicians and Surgeons and their Families. It seems that the physicians and surgeons in New York give the public annually, free of charge, services which are estimated to be worth at least fifteen million dollars; while the country at large receives free services worth one hundred and thirty-five million dollars. This statement is based only on what is known as "free hospital days" and it takes no note of visits to patients who can not, or will not, pay for such services. The estimate was arrived at from returns from 107 out of 140 medical and surgical serving institutions in which, during twelve months, New York medical men gave 5,020,502 "free hospital days" which at three dollars, give us a total of $15,061,506.

We confess that these figures are amazing. They assist in answering the question as to why so many physicians make barely enough for a decent existence; why the majority (so the director tells us) die without estate; and why many become public charges because of financial difficulties. So when anyone of you finds himself the subject of exorbitant medical charges (and that such charges are too frequently made is attested and condemned, now and then, by leading physicians) bear in mind the enormous amount of charitable work mentioned above, and do not allow the extortions of the few to cloud the honor which belongs to the great body of medical men as a whole.

The House Naval Bill

THE discussion of the House Naval Bill by the Naval Commission has revealed a sharp division of opinion among the ranking officers of the Navy, particularly as to the future policy in regard to the construction of dirigibles. Secretary Wilbur and Admiral Jones are opposed to the construction of a new dirigible to take the place of the *Shenandoah;* and they are in favor of closing down the activities of the naval station at Lakehurst, New Jersey. They recommend that the sum appropriated for the maintenance of Lakehurst station be reduced from $1,880,000 to $130,000. In other words, the magnificent hangar will be practically put out of commission and the *Los Angeles* with it.

We believe that the closing of the Lakehurst station (for it practically amounts to that) would be a serious mistake, defeating the very object of economy at which it aims. The large sums of money which have been expended on lighter-than-air craft and the acquired experience in designing and operation, constitute an asset whose value will very largely be lost if the Navy closes and locks the gate on future development. The Aeronautical Bureau wishes to embody its experience in a new and larger ship and suggests that this is the time to carry forward our experimental work with vigor. To close the Lakehurst station and abandon all work on airships would be considered throughout the world as a confession of failure upon the part of our Navy.

If we object to the aeronautical policy advocated by the Committee, we are, on the other hand, heartily in sympathy with its proposal to secure economy by placing some of our battleships out of full commission and maintaining them with skeleton crews. "With respect to putting some of our vessels in reserve," says the report, "it should be pointed out that Great Britain has but thirteen of her eighteen capital ships in full commission. We have had eighteen until recently, when three were detached and decommissioned for modernization." The difference between keeping eighteen and a dozen modern battleships in full commission would represent a large saving of funds which could be expended where they are desperately needed—namely, in the construction of large cruisers and fast scouts, in which our Navy has a lamentable deficiency.

Star Clusters

There Is a Close Relation Between the Brightness and Spectral Types of Their Component Stars

By Henry Norris Russell, Ph.D.

Professor of Astronomy at Princeton University. Research Associate, Mt. Wilson Observatory, California

THE stars are decidedly gregarious; although they are scattered all over the vault of heaven, they congregate here and there into groups and clusters, some of which are conspicuous enough to have received names in antiquity which are still in use.

The best known of all these clusters is the Pleiades—which from its compact character, and the brightness of its constituent stars, cannot fail to attract attention. The more straggling cluster of the Hyades—also in the constellation Taurus, was likewise known and named in Greek times. The smaller and denser cluster in Cancer which appears to the eye as a hazy spot of light, but shows its separate stars with a field-glass, bears the Latin name Praesepe; and another loose cluster, farther east in the skies, has been raised to the dignity of a constellation, under the name of Coma Berenices—commemorating the beauty of the hair of some fair lady of classic days.

Galactic or Open Clusters

These four conspicuous groups are examples of a type which finds hundreds of representations among telescopic objects—the so-called "open clusters." This name is given them in antithesis to the far richer and more condensed "globular clusters"—from which they differ in the smaller number and more open array of their stars. In their situation in the heavens, too, they are unlike the others, being for the most part in the Milky Way—for which reason they are sometimes called "galactic clusters"—while the globular clusters avoid this region of the sky.

They differ, too, from the globular clusters in being much nearer. While the nearest of the latter is twenty thousand light-years away; the nearest open cluster—the Hyades—lies at a distance of only 140 light-years—less than one percent as far away. Several of the other clusters are real enough to show definite proper motions—all the cluster-stars moving together in space like a flock of birds in the sky—while the globular clusters are so remote that their motions, though really very rapid, appear imperceptible.

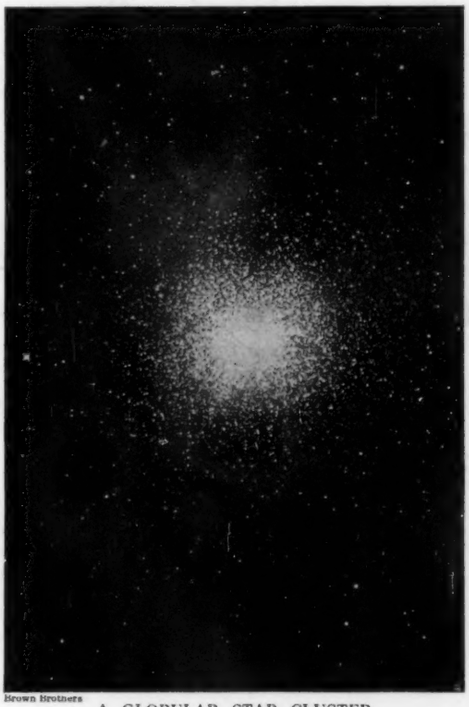
Measuring Their Distances

By indirect methods the distances of all the star clusters have been accurately measured by Dr. Harlow Shapley, taking advantage whenever possible of the luminosity-period relation that obtains in the Cepheid variables. Apparent diameter of the cluster and its distance may be correlated on the assumption that globular clusters are of the same order of linear dimension.

Where no Cepheid variables are present another method is employed. It is assumed that the typical giant stars of the cluster have about the same absolute magnitude, and that this holds good for all the clusters. Therefore the apparent magnitudes of the twenty-five brightest stars of the cluster in question are determined, and since their absolute magnitudes are known, as mentioned above, their distances may be easily deduced by comparatively simple mathematical formulae.

It is not surprising, therefore, that individual stars of the open clusters appear to us much brighter than any in the globular clusters. This makes it possible to study them individually—for example, to photograph their spectra.

In the brighter clusters, it has been known for many years that the relation between the brightness and spectral type of the stars is very close. The brightest stars of the cluster are white, the fainter ones, yellowish and the faintest are yellow, or even reddish. This is exactly the relation which is found among the majority of the stars whose distances and real brightness are known, and is characteristic of the "main sequence" of stars of which we spoke a few months ago.



Brown Brothers

A GLOBULAR STAR CLUSTER

Its diameter is at least 1,000,000,000,000,000 miles. Our sun may be thought of as lying near the center of a cluster such as this. Such clusters are not compact

In this sequence the average brightness or "absolute magnitude" of the stars varies rapidly with the spectral type—stars of class A, like Sirius—averaging about thirty times as bright as the sun—those of class G—like the sun—being of about the sun's brightness, and so on.

In the Hyades cluster, where the distance can be found accurately by other means, exactly the same relation between absolute magnitude and spectral type holds true. In the other clusters, for which the distance has not been directly measured, the relative brightness of the whiter and redder stars follows the same law; but the apparent brightness of the stars, as we see them differs widely. It is natural and reasonable to attribute these differences to differences of distance from one cluster to another—the stars in the remoter clusters appearing fainter. In this way it is found that the Pleiades and Coma Berenices are at distances of about 300 or 350 light-years and the Praesepe group a little farther off, perhaps 450 light-years.

A systematic study of the fainter clusters has been made—indeed is still under way—by Dr. Trümpler of the Lick Observatory. Working with specially designed spectroscopes of great light-gathering power he has determined the spectral types of the stars in more than fifty clusters. In every case but one, the same steady gradation of color with brightness presents itself and it is evident that most of the cluster stars belong to the main sequence.

In rather less than half the clusters, yellow or red giant stars, about as bright as the white stars of class A, are also present—for example in Praesepe, Coma Berenices and the Hyades. In the rest, for example in the Pleiades, all the stars belong to the main sequence.

No Strict Uniformity

A few scattered stars which do not conform to either of these groups are doubtless interlopers—stars which do not belong to the cluster at all, but lie in front of it or behind it. For some of the near clusters, this suspicion is turned to proof, when it is found that the suspected stars are moving in different directions, or at different rates, from the members of the cluster.

In the one aberrant case—a loose cluster of relatively few stars—there is no recognizable relation between brightness and spectrum, and it is probable that this is a mere chance agglomeration of unrelated stars.

For all the other clusters, the grouping evidently corresponds to a real association of the stars in space, and the distance of the cluster can be found from the difference between the apparent and real brightness of the stars of a given spectral type.

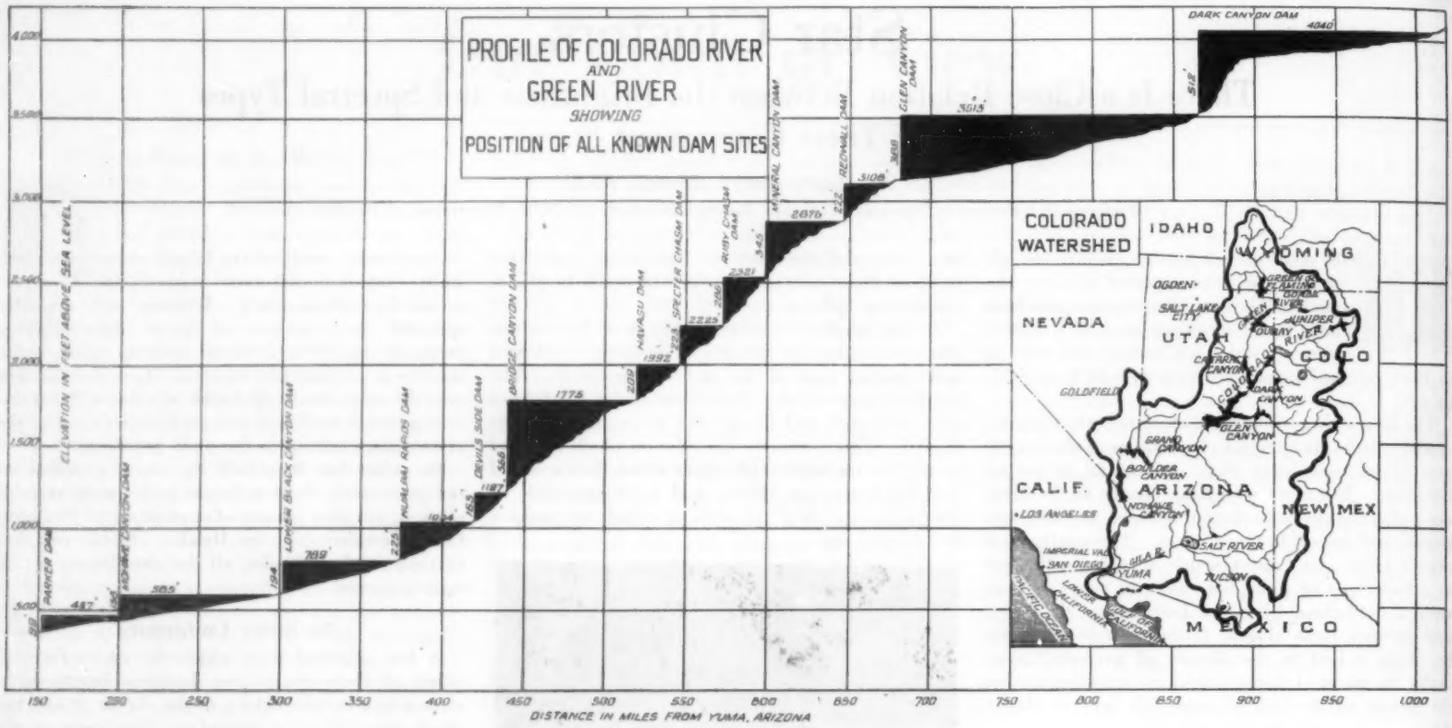
Clusters in Evolution

Dr. Trümpler thus finds that the four bright clusters which have already been named are the nearest. The others have distances ranging up to 16,000 light-years—most of them lying between 1,500 and 6,000 light-years. This shows that they lie well out in the Milky Way, although the remotest of them is nearer than the nearest of the globular clusters.

Why some of these clusters should contain red or yellow giant stars and others none demands explanation, and this demand is intensified by Dr. Trümpler's discovery that whenever the cluster contains stars of class B—the brightest and hottest of all—the redder giants are absent. He makes the reasonable suggestion that this is a matter depending on the age of the cluster.

If—as is now very generally believed—the stars start their careers as red giants, develop first into stars of class A or B and then fade gradually into dwarf stars, only the relatively young clusters should contain giant stars of low temperature. In the course of ages, these red stars should gradually grow yellow and then white, finding no successors to take their places, and thus a group like the Hyades would turn ultimately into one which roughly resembles the Pleiades.

The fact that the B-stars, when present at all, are much brighter than any others—averaging more than a thousand times as bright as the sun, is not, however, fully explained. But the interpretation of this may come with a continuation of the studies which are now in progress.



The Subjugation of the Colorado

Substituting Power, Light and Fertile Lands for Disastrous Flood Waters

By Guy Elliot Mitchell

THE great Colorado River of the west is no longer a mystery, an unknown danger. It has given up all of its secrets to engineering and scientific exploration and, even now, definite plans have been formulated to prevent its disastrous floods, to harness its vast power and to spread its huge volume of fertilizing, irrigating waters over millions of desert acres. The complete subjugation of the Colorado is an engineering undertaking of stupendous magnitude—one, not of millions but of hundreds of millions of dollars of cost.

The Monster Will Be Tamed

The Colorado has its source in the high mountains of the Continental Divide. Its waters drop some 14,000 feet in their 1,500-mile course to the sea. Every workable horsepower in that great fall is to be utilized as needed—and, after this energy has been harnessed, the same waters, gathered from a watershed of 244,000 square miles, will be led out to irrigate millions of acres of thirsty, desert lands and there to produce crops of fabulous magnitude.

If there is poetry in engineering, surely the Colorado is a fascinating theme for contemplation. A wild and cruel monster, a giant of destruction to human life and property, its evil tendencies may all be corrected; it may bring staple foods and luscious fruits to millions of people; it may turn the wheels of a thousand industries; and though now a region of almost utter inaccessibility, a fact not very generally realized, it may become a place of lake and canyon splendor surpassing perhaps anything in the world, to be visited with ease and comfort.

Looking somewhat ahead of the present interest in the Colorado, the United States Geological Survey has for many years been making a close study of the river and its great watershed. The Survey's hydraulic and topographic engineers have traversed and mapped every foot of its great canyon and its many tributary canyons, and its geologists have examined the rock structure of its multitude of dam and reservoir sites; for the river can be controlled and utilized only by the creation of great artificial lakes or flood-storage reservoirs. We are apt to think of storage reservoirs as ponds of a score or possibly a hundred acres or so in extent, retained by masonry walls; but the storage lakes of the Colorado will be hundreds of square miles in extent and they will be bounded by rugged canyon walls.

The volume of the flow of the Colorado and that of its tributaries has been measured and plotted by the Geological Survey engineers during a period of over twenty years. This close scrutiny of the behavior of the river, of its range in flow from a comparative trickle of 3,000 cubic feet of water per second to wild floods of over 200,000 second-feet, and the examination of inaccessible dam sites, culminated two years ago in the voyage by engineers and geologists through the 200 most dangerous miles of the Grand Canyon itself.

RAINBOW NATURAL BRIDGE

Three hundred feet high, chiselled out of one solid mass of rock by the age-long action of the elements

And now comes the result of this labor of magnitude, analyzed and presented in a government engineering report—a definite plan for the complete subjugation and utilization of the river. It is a project to construct 13 great dams and reservoirs and create hundreds of miles of artificial lakes, whereby all the floods of the Colorado will become only historic; since they will be converted into a great resource by the utilization of all the water for power and irrigation.

One Comprehensive Plan Essential

E. C. LaRue, the author of the Colorado River report and plan, is a hydraulic engineer of the Geological Survey, and throughout the southwest you may often hear him referred to as the "father of the Colorado." He has known the river for half a lifetime; he has made hundreds of miles of boat trips through its wild and treacherous canyon reaches, charged with the responsibility of selecting all possible dam sites and supervising their survey.

But even in this report, the Geological Survey is not presuming to promote any particular power or irrigation project. It is making available the mass of information needed for outlining a feasible scheme for the full development of the river and especially for an orderly and wise planning. The river must be developed as a single undertaking, piecemeal it is

true, but according to a general plan; and no single or initial project must be permitted which will ruin or detract from the later and greater possible ultimate development. In order that this may be accomplished, there must be government regulation of the engineering phases of the work.

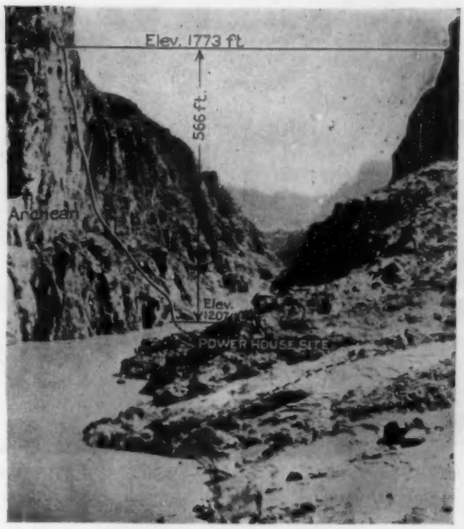
The beginning in construction will doubtless be to prevent flood damage. There is urgent need for the building of a dam to protect the hundred or more million dollars invested along the lower reaches of the river in the Imperial Valley and elsewhere. The recurrence of any one of the big floods of the Colorado would wipe out this property and perhaps cause great loss of life—and it may come next year, or in any year. It is also probable that a dam for the development of power will be built at an early date. But these or any other dams should be built as part of the whole, big adventure.

In developing the water resources of the United States, Mr. La Rue states, the haphazard policy under which our cities have been laid out has been followed. In the development of our important rivers, he fails to find an instance in which a comprehensive plan of development was prepared in advance of construction. Engineers have been sent into the field to locate sites where water might be stored or power developed at a minimum cost. Almost without exception the projects for immediate development have been selected with little regard for future developments.

Its Value for Irrigation and Horsepower

Summarized, the thirteen-dam-plan would make available 3,383 feet of fall in the 860 miles of the Colorado below its juncture with its principal confluent, Green River, for the development of power, and a maximum of 42,000,000 acre-feet of storage capacity for the control of floods, the equalization of flow and the storage of silt. Including full development in the upper basin, it would make possible the irrigation of nearly 6,000,000 acres and the generation of 3,420,000 continuous horsepower. Under an annual load factor of 60 percent the aggregate installed capacity of the plants would be 5,743,000 horsepower. It would also provide a domestic water supply for a population of 10 to 15 million in urban communities in the southwest.

A brief glance at two or three of the dam-site and reservoir projects included in Mr. La Rue's plan will be of interest. The Ouray headwater reservoir site is on the Green River in Northeastern Utah. With a moderate sized dam, 170 feet high, a reservoir would be formed with a capacity of



BRIDGE CANYON DAM SITE
The side walls are of granite. The dam would develop over 600,000 continuous horsepower

8,000,000 acre-feet.* This reservoir would regulate the flow of the Green River for adjacent irrigation and power; but it would also be beneficial to irrigation and power on the Lower Colorado. The stored water, as released, might eventually pass through power houses with an aggregate head of more than 3,400 feet, and the flood flow of the lower river would be materially reduced. If the flow of the Green River were thus regulated, less storage capacity would be required at all hydraulic structures built on the lower river, whether operated in the interests of flood control, irrigation or power development, a fact which appears to show the wisdom of a plan involving up-stream storage.

The lower end of Glen Canyon reservoir site, one of Engineer La Rue's thirteen, is located just above Lees Ferry. A dam 386 feet high, cementing together the precipitate Jurassic sandstone walls of this part of the Grand Canyon, would back the water up the Colorado, forming a narrow lake over 175 miles long, and would store 8,000,000 acre-feet. This would remove the flood menace on the river below, and would reduce the cost, by millions of dollars, of all dams subsequently built below this canyon. There are ten such dam sites below, where a total head of 2,523 feet may be utilized for power development. At present, without storage, the total power capacity of these ten sites is 1,758,000 horsepower; but with storage in Glen Canyon reservoir their capacity would be increased to 4,345,000 horsepower. That the construction of this single dam is a stupendous undertaking is seen from the statement that to complete the underwater foundation work on the dam it would be necessary, in the long interval between successive annual floods, to pour between 5,000 and 10,000 cubic yards of concrete a day.

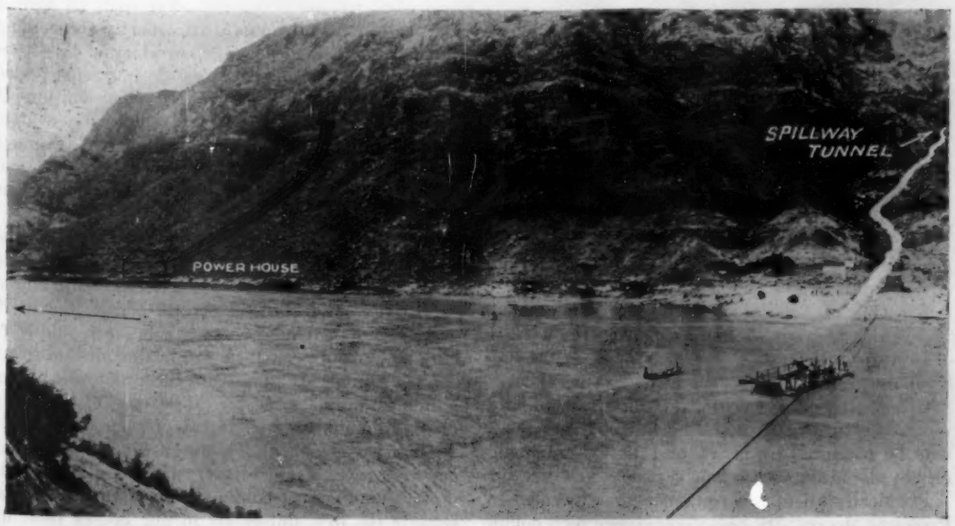
* Acre-foot equals one acre of water one foot deep.

Glen Canyon is a remarkable dam site. By about doubling the height of the proposed dam, the reservoir thus formed would store more than twice the entire annual flow of the Colorado. Immediately above the head of Glen Canyon reservoir would rise the dam of the Dark Canyon reservoir 148 miles long, which would carry the chain of reservoirs up to over a hundred miles beyond the confluence of the Green River with the Colorado River. Another great lake would be the Mohave reservoir at the extreme lower end of the Grand Canyon, which would store 10,400,000 acre-feet of water and form a lake 100 miles long and five to eight miles wide. Another remarkable site is at Bridge Canyon where a dam 566 feet high, between granite walls, would take the water out of the river on the 1,773-foot level—above sea level—for irrigation purposes, and would develop over 600,000 continuous horsepower.

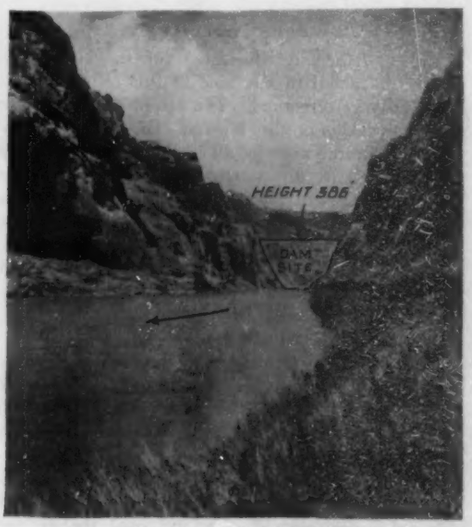
Will Provide Scenic Beauty

There must be a further word touching on the scenic development that would result from the adoption of La Rue's suggested plan. From the town of Parker, down in Arizona, all the way up to the confluence of the Colorado with the Green River in Utah, the thirteen reservoirs would form a chain of lakes of practically unbroken continuity. These lakes would vary in width from narrow fjord-like bodies of water, deep down below precipitate walls and cliffs thousands of feet high, to others several miles across.

Among other present inaccessible wonders, the Rainbow Natural Bridge would be brought to within a mile of the shore of the Glen Canyon reservoir-lake. This graceful, natural arch of sandstone is high enough to span the dome of the Capitol Building at Washington and surpasses in size and symmetry any other known natural bridge. Mr. La Rue, although a hard-headed engineer, ventures in his report the belief that, after the completion of automobile highways leading to the Glen Canyon Lake, the tourists to this section alone would number hundreds of thousands annually.



COLORADO RIVER BELOW GLEN CANYON DAM
The dam would develop 334,000 continuous horsepower. The water is carried through a tunnel to discharge into penstocks, thence down to the power house (left). The overflow discharges through a tunnel (right)

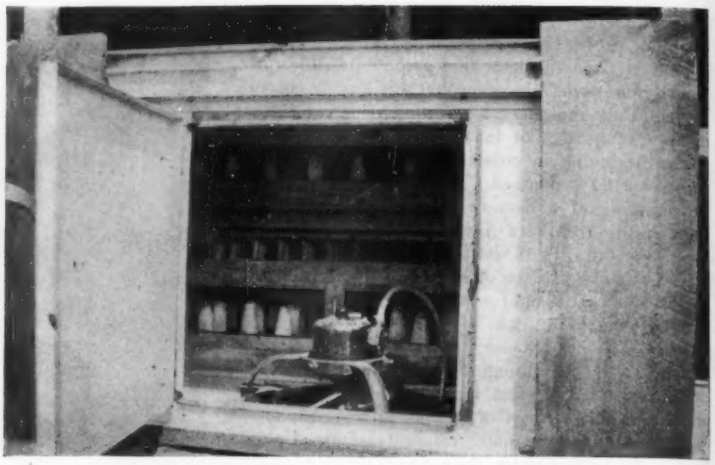


GLEN CANYON DAM SITE
This dam, 386 feet high, would form a lake, extending for 175 miles up the Canyon

Photographs by Lee McRae

DR. MOORE AND HIS AIR GATHERER

A and B are wind-vanes which control the intake and outflow apparatus



THE AIR WASHING AND COOLING APPARATUS

Here the air is cooled as much as thirty degrees on a hot summer's day

Cooling Your House in Summer

How a Former Chief of the Weather Bureau Solved the Problem of Keeping the Air in His Home Cool in Hot Weather and Moist in Winter

DR. WILLIS L. MOORE, for twenty years chief of the United States Weather Bureau, former President of the National Geographic Society, and founder of the *National Geographic Magazine*, has found a practical way to maintain the air in his home at Pasadena, California, both cool in summer and hygienically moist in winter.

In summer, the Professor takes in air from a large scoop on the roof, washes it, cools it in a simple apparatus and then passes it all through his house by means of ducts. In winter, he maintains the relative humidity of the air at seventy percent, where it ought to be, by means of a special humidifying heater.

The summer apparatus consists of air-scoops on the house roof, an air washer and air cooler, a fan and eight-inch conduits leading to the various rooms; also registers for controlling the inflow. With this simple equipment, Dr. Moore has found that the house may be closed as tight as a drum, yet in the extreme heat of summer the temperature will not exceed 80 degrees.

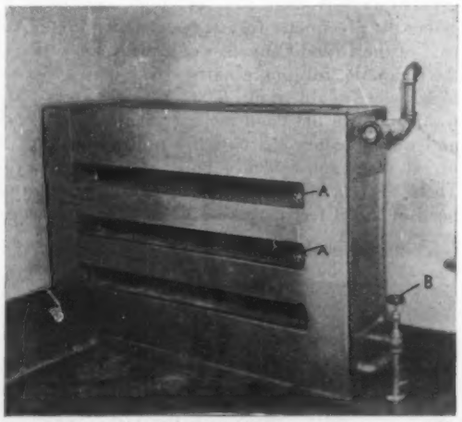
Windows Never Opened

In the left-hand illustration of the two shown above, the detail of one side of this four-sided air-scoop may be discerned. You are looking into three separate ducts, at the level of Dr. Moore's hand. Imagine several more of these ducts radiating from a center, in all directions of the compass, so that some of them will always catch the breeze. At the center there is a vertical, metal cylinder with one-fourth of its circumference cut away, thus leaving an opening into which the wind collected by the scoop ducts may blow. This opening is always kept directed towards the proper scoops by means of a wind vane which shows at A.

The air rushes into the scoops and since they are narrower at the center, it gains velocity. This forces it out of the end of the cylinder and through the washing, cooling and moistening vats which are contained in the box just behind Dr. Moore.

In the illustration on the right, above, the contents of this box are shown. The fibrous, cloth-covered cones, which wash and cool the air, are shown projecting out of the water. In passing through this part of the equipment, the air, when its temperature is high, is cooled some 30 degrees.

In the same box an electric fan is shown. This fan may be used to force the washed and cooled air down through a number of eight-inch ducts to the ceilings of the rooms, where its inflow may be controlled by registers. Thus, with this fan, all of the air may be changed within eight minutes. However, it is rarely that this fan is needed. Careful tests have shown that without the fan a wind blowing at the rate of only three miles an hour will completely change the air in the house within fifty minutes.



THE HUMIDIFYING APPARATUS, USED IN WINTER

The heat is turned on by means of valve B. Valves A, A, are for controlling the amount of humidity

In each room there are two registers on the ceiling, one being the inflow register, the other the outflow register. The latter lead to exhaust flues on the roof. One of these flues, equipped with a wind-vane which keeps it pointed away from the wind in order to provide suction, is shown at B, in the left-hand illustration, above.

Ordinarily, the circulation of the air within the rooms is almost imperceptibly gentle, yet its velocity may be measured by means of little, spinning air-meters placed on each inflow register.

Practically all of this equipment was invented by Professor Moore. His house is equipped with double windows, and so efficient is the air-circulating apparatus that in the period—almost two years—since his house was completed *not a single window has been opened*. There is no need to open them. Moreover, double windows are a discouragement to burglars.

Between the double windows and between the double walls of the house there is also a constant air circulation. Every room in the house has its own thermometer and hygrometer and these tell at a glance, the temperature and amount of moisture in the air.

The humidifying apparatus for winter use consists of a heater, shown in the illustration in the middle of the page. This heater has four units. Water is let into each unit separately, by means of a valve. A float maintains this water at constant level. By manipulating the valves the desired percentage of relative humidity in the house may be controlled. In practice, in Dr. Moore's house, one, or at most, two of the units provide enough moisture to keep the air at 70 percent relative humidity.

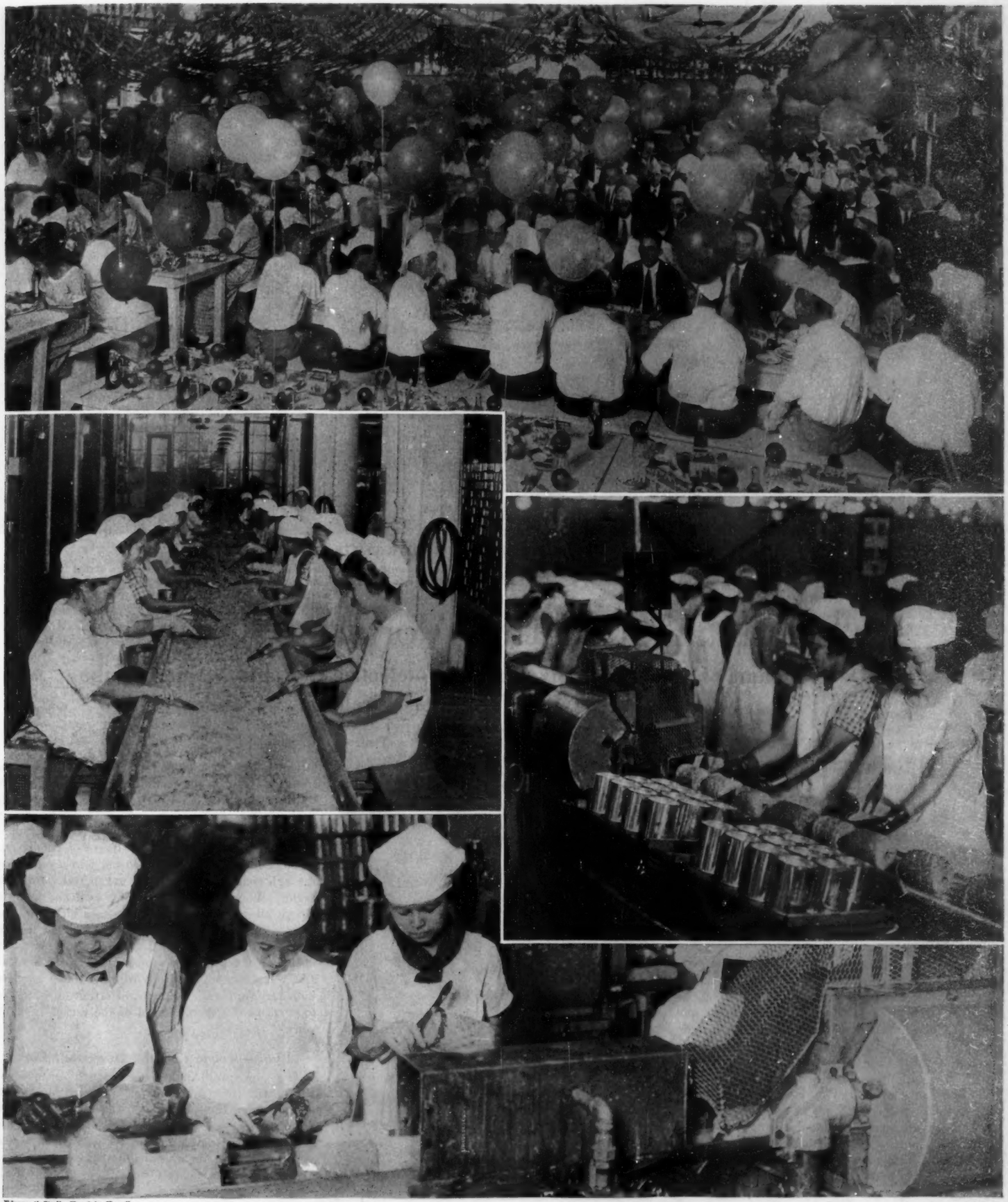
Hot Air Is Thirsty

Few people know the effect on the contained moisture when we warm our air. For each 18 degrees that we heat it, air *doubles* its capacity for holding moisture. What, then, is the corollary of this statement? It means that since we do not usually give our air a chance to take up this needed moisture, it goes without.

No, it does not entirely go without, it abstracts all the moisture it can get from our woodwork and our furniture, which dry up, shrink and crack. Far worse, it takes moisture from *us*!

As was recently pointed out in the *Journal of the American Medical Association*, when we take cold air from out-of-doors at freezing temperature and at a relative humidity of 80 percent and heat it to 70 degrees, we thereby reduce its relative humidity to only 20 percent. We then live in this air and so we become kiln-dried, along with the woodwork. Office buildings, heated to nearly 80 degrees, often have a relative humidity of as low as 15 percent.

Thus we get the hot-house habit. We become hypersensitive, afraid of every chill and every little draft. We also get colds, grippe, even pneumonia, because the dry, thirsty air of our houses blots up the moisture of our throat passages and reduces their natural resistance to infections.



Edgeworth Studio, Honolulu, Hawaii

Scenes in a Pineapple Cannery in Hawaii

TOP: The employees of a big pineapple cannery represent all races. They are shown here enjoying a Christmas dinner in their cafeteria. LEFT: Hawaiian, Filipino, Chinese, Japanese, Korean and Portuguese girls work side by side. Here they are removing skin specks from the shredded pineapple. RIGHT: Girls sorting slices of pineapple. LOWER: Cutting off the edges of the pineapple skins by hand. The workers wear rubber gloves to insure cleanliness.

RADIO MOVIES THROUGH AN ORDINARY RECEIVER

C. Francis Jenkins, of Washington, demonstrating his radio motion picture receiver for use in homes. A miniature screen is placed on the wall, and a distant scene in action is reproduced. This shows the picture of a girl dancing at the transmitting station, detected by an ordinary broadcast receiver

Seeing Around the World by Radio

The Development of a New Combination Photo-electric Cell and Vacuum Tube Has Created an "Eye" for Wireless

By Orrin E. Dunlap, Jr.

RESEARCH engineers are making rapid progress in developing an "eye" for broadcasting, so that television, or seeing distant scenes by radio will be as common as tuning in music. It has been learned upon good authority that television apparatus in simple form will be on the public market just as soon as all phases of the system are protected by patents.

Scenes Sent Through Space

When the radio optic, and its associated instruments, is released to supplement broadcast service, it will work in conjunction with the microphone, the former picking up light waves, so that they can be transformed into electricity and radio waves, and the latter doing likewise with sound. Then the radio announcer will snap a switch connecting the mechanical eye and ear with the transmitter and all scenes and sounds within range will be sent through space to millions of homes. For example, the eye-ear device might be placed in front of Niagara to record the thunder of water, camera the spray cloud and forward the picture along with the roar to firesides and schools throughout the nation, and some day to a world-wide audience.

It will all be true to life and nature, is the prediction of radio men. Today it may seem far-fetched; but so did broadcasting six years ago. Those in touch with the research laboratories know that television will be a reality. Today there are approximately 1,000 broadcasters in the world; and when they are equipped with "eyes," the scenes of the earth, now thousands of miles apart—from the Orient to America, from New York to Moscow and from the North to the South Pole—will be separated by just a few marks on the scale of a simple tuning device.

Kadel & Herbert

INVENTOR AND HIS RADIO "EYE"

V. K. Zworykin, research engineer, who has produced the combination photo-electric cell and vacuum tube which experts say is the basis of television. Compare the new tube with a modern receiving tube, held in his left hand

When a broadcasting station goes on the air there is a carrier current or steady stream of energy sent through the ether. It serves as a wire or pathway through space over which the music and words take flight. When the microphone is switched into the circuit all sounds within its range are picked up and their vibrations in the microphone cause corresponding fluctuations in the electrical circuit connected to the broadcast transmitter. Thus, the carrier wave is modulated accordingly, that is, instead of it being a constant flow of electricity it is shaped to correspond with the tones of the music or of the voice.

Photo-electric Cell the Important Link

The main problem has been to produce a device which will treat a shadow as the microphone does a whisper. The photo-electric cell, employed in various processes, is apparently the important link in the chain of developments, which will make television and radio movies possible. The fundamentals of the photo-electric cell were discovered by Hallwachs, a German physicist. The principle is based upon the fact that certain metals give off electrons when their surfaces are illuminated. Generally, an alkali metal is employed, such as potassium, sodium, caesium, rubidium or lithium.

This cell has been combined, by V. K. Zworykin,

a physicist of the Westinghouse Electric Research Laboratories, with the radio vacuum-tube amplifier to form a new step in science. It resembles the ordinary vacuum-tube detector and amplifier used in broadcast receivers, but variations of light falling on this device instantly become variations of electrical current and are amplified thousands of times. The current, which the light waves create as they strike the tube, is amplified by the tube itself.

The photo-electric cell is built into the tube, one end of which is coated on the inside with potassium, or an alkaline metal which throws off showers of electrons when light falls upon it. This electron stream is an electric current. The electron flow is feeble if the light is weak, heavy if the light is intense. Thus the variation in light governs the strength of the electron shower. In order to prevent the light from the filament falling on the sensitive film of alkaline metal, metal shields are used and the filament is operated at a temperature below visual emission.

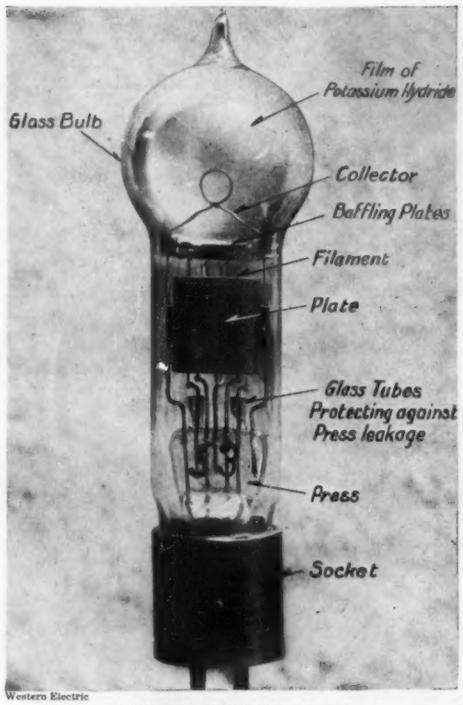
Smoke Rings Bell

The device is so sensitive to light variations that a thin veil of cigarette smoke was utilized to ring a bell in the initial demonstration. The smoke was blown so that it drifted between a light and Zworykin's mechanical optic. The smoke intercepted sufficient light to reduce the electrical current, which the illumination from the lamp had been actuating. The reduction in current caused a switch to close and completed an electrical circuit in which the bell was located. The "eye" was then used in connection with a loudspeaker which howled when a wire one millimeter thick was passed between the source of light and the photo-electric cell.

It is understood that the Westinghouse Electric and Manufacturing Company are developing a process for broadcasting pictures, and that this new tube is the basis of the system. Mr. Zworykin has pointed out that all the processes needed for television, or the projection of motion pictures by radio, are already in existence.

"The theory is all right," he said, "but at present the apparatus would have to be endless, cumbersome and uncertain. But it will be simplified. It will take some years; but we will have eventually the instantaneous or nearly instantaneous transmission of motion pictures."

By selecting the suitable electrical characteristics



Western Electric

RADIO'S SENSITIVE OPTIC

So sensitive is the Zworykin photo-electric vacuum tube to variations in light that a thin screen of cigarette smoke will act upon it and create a howl in a radio loudspeaker. Engineers expect that it will serve to broadcast light just as the microphone broadcasts sound

of the tube and the accompanying batteries, Mr. Zworykin has produced a device in which no current will flow through the tube's plate circuit when the sensitive metal film is in darkness; but as soon as light strikes this alkaline film, the electrical barrier averting the flow of current is removed and the current will flow through the plate circuit of the tube in proportion to the intensity of the light falling upon it.

In daylight, or under an electric light, the current flow thus produced is sufficient to operate a standard telegraph relay, which in turn can be arranged to control electrical or other apparatus to any desired extent. By reversing connections, the effect of the operation of the tube can be reversed, so that it will produce current in darkness, but will prevent current flow although it may be fully illuminated.

The instrument is useful as a fire alarm in such places as the holds of vessels, automatic, unattended electrical stations, storerooms of buildings and other places. At the least suggestion of smoke, caused by overheating from any cause, an alarm can be sent out by both wire and radio to any desired stations. It can be employed in connection with variations of light for any purpose, such as the exact matching of colors, detection of flaws in tinplate and textiles, the turning on of street lights at twilight and extinguishing them at dawn, and for innumerable other applications of similar nature.

The reaction of the Zworykin tube to light variation is extraordinarily rapid, being on the order of one-hundred thousandth of a second; and since, when incorporated in a suitable circuit, it will send out radio impulses of any desired frequency in direct proportion to the amount of light falling upon it, it has opened the way for the development of television.

Will Radio Travel Everywhere?

C. Francis Jenkins, the Washington inventor, who has demonstrated a machine for sending silhouettes of moving objects, which some have termed the real step in the broadcasting of movies, uses a photo-electric cell in his apparatus to convert the high lights and shadows of objects into corresponding intensities of electric current. Captain R. H. Ranger, an engineer of the Radio Corporation of America, who has developed a pen-and-ink method of reproducing pictures sent by radio, also employs a photo-electric cell as the "eye" of his system.

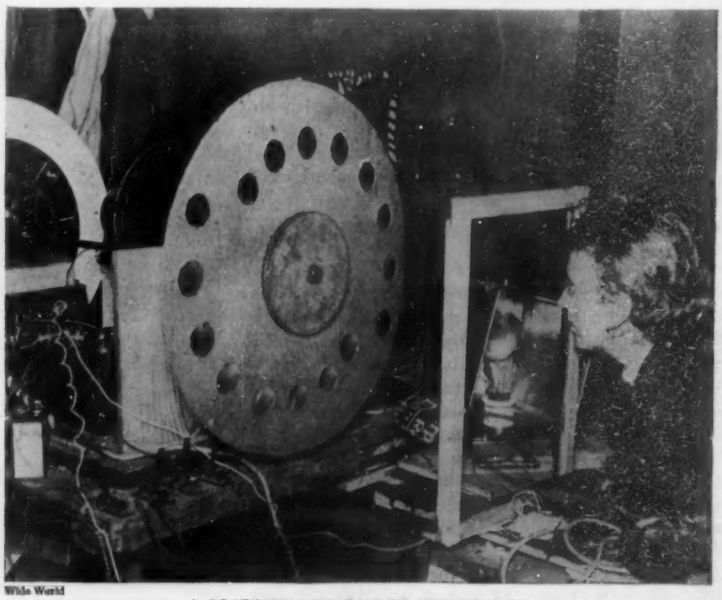
Mr. Jenkins, in explaining the essentials of television, says, "If one puts his head under the black cloth of an old-fashioned camera pointed at a baseball game he sees in miniature on the ground glass an exact reproduction of the game as it progresses. It is carried by light from the ball diamond to the ground glass screen. That is exactly what we want, only we want it in our homes. Light working alone will not do it, for light goes only in a straight line, and obstructions cut it off; we must, therefore, have some kind of carrier which can go around obstructions and through the walls of our homes. A copper wire will do, but a wire carries only to one place.

"Let us take radio that travels everywhere!"

Kadel & Herbert

SHADOW ELECTRIC APPARATUS

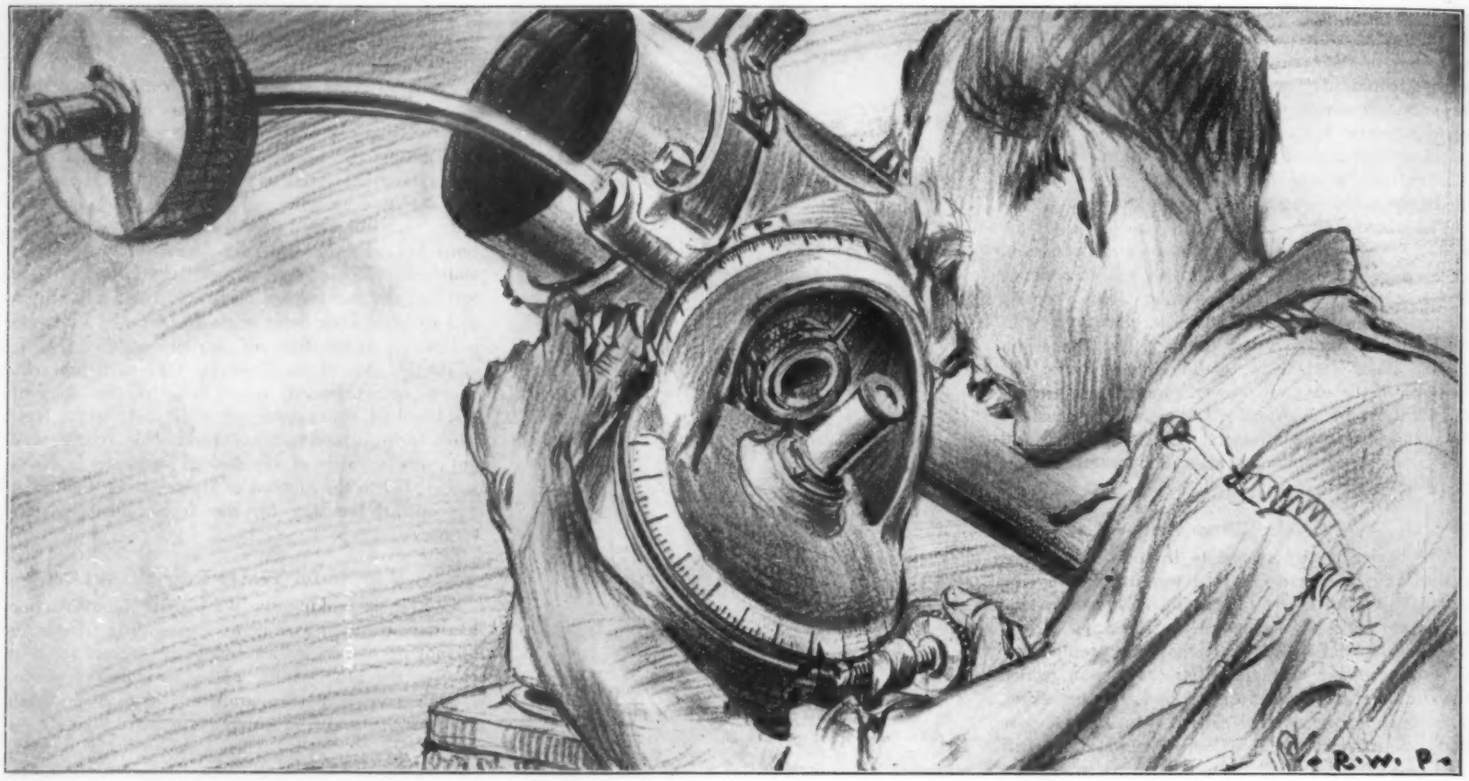
The combination photo-electric cell and vacuum tube in a radio set is so sensitive that it is energized with a shower of electrons when the slightest shadow crosses its light



Wide World

A BRITON'S VERSION OF TELEVISION

Through this complex layout of wires and disks a British experimenter is seeking a system for sending pictures through space from one distant station to another by radio



The Springfield equatorial mounting, showing its fixed eyepiece and the convenient arrangement of the slow motion controls and setting circles

Mountings for Reflecting Telescopes

By Russell W. Porter, M.S.

All Drawings by the Author

SEATED well up in the bleachers (Latitude 43° N) we amateur astronomers in Springfield, Vermont, can command a fine view of the greatest of all spectacles—the solar system. Among its planets the race is always on. The entrants gain and lose on each other as they pass us by. Until Copernicus somewhat rudely shoved us over to one side, we thought we saw the show at first from a central coign of vantage. However, the change was not all a loss, for it placed us on a movable platform where we became a real participant.

I always like to think of this old earth of ours as a gigantic piece of exquisite mechanism with which, by the aid of a mirror of my own making, I am privileged to play at will. But, before I may appreciate the beauties of this mechanism, my mirror, along with its prism and eyepiece, must be properly mounted.

The Fundamentals of a Mounting

The essentials of an efficient reflecting telescope mounting are: that the optical train—mirror, prism and eyepiece—be held rigidly in relation to each other; that provision be made for conveniently adjusting these parts; and that the whole be supported on bearings, permitting any celestial object to be easily followed as it moves across the sky.

The first of these conditions is readily met by the use of a tube of sheet metal to which the different optical parts are attached. Since the hollow cylinder is one of the stiffest forms for its weight and can be obtained at any tinsmith in galvanized iron at moderate cost, the reasons for its use are obvious. The mirror A (Figure 1) rests in a cell B, fastened to one end of the tube C. The eyepiece F fits into another tube E called the adapter, which slides easily in a flanged piece D fastened to the side of the telescope tube. The prism G (hypothenuse side) is held against a corresponding face on member H. A stud on the rear of H fits in the sleeve I held to the telescope tube by the three knife-edges J. The knife-edges have threaded ends. They rest in slotted holes in the tube and are provided with set nuts. With this arrangement the prism may be adjusted to bring it into proper relation to the mirror and eyepiece.

THE SPRINGFIELD MOUNTING IN USE

The observer's position is fixed (note the bicycle seat). The light reaches his eye through two prisms

This solution of our first and second essential conditions is the one now in almost universal use. When taken indoors for safe keeping, the optical parts are easily removed without disturbing their adjustments. An additional refinement is a focusing rack and pinion. Sometimes a diagonal, flat piece of glass (silvered on its front surface) is substituted for the prism, but this is not advised because it adds an unnecessary silvered surface to be protected. The prism is not silvered and is totally-reflecting, owing to the acute angle which the light strikes its hypothenuse side.

What an Equatorial Mounting Is

The tube must now be supported so that it will follow the stars. Of the several ways by which this may be accomplished, one condition underlies them all—there must be provided two bearings at right angles to each other, and one of them must be capable of being adjusted parallel to the axis of our earth. A familiar instrument having these two bearings at right angles to each other is the surveyor's transit or theodolite. One of the axes (A-B, Figure 2A) is always plumb. Imagine the instrument tipped over until this axis is parallel to that of the earth (second drawing of Figure 2), and we have what astronomers call an equatorial mounting. The axis about which the telescope swings is called the declination axis.

To visualize this condition of parallelism between the polar axis of the mounting and the axis about

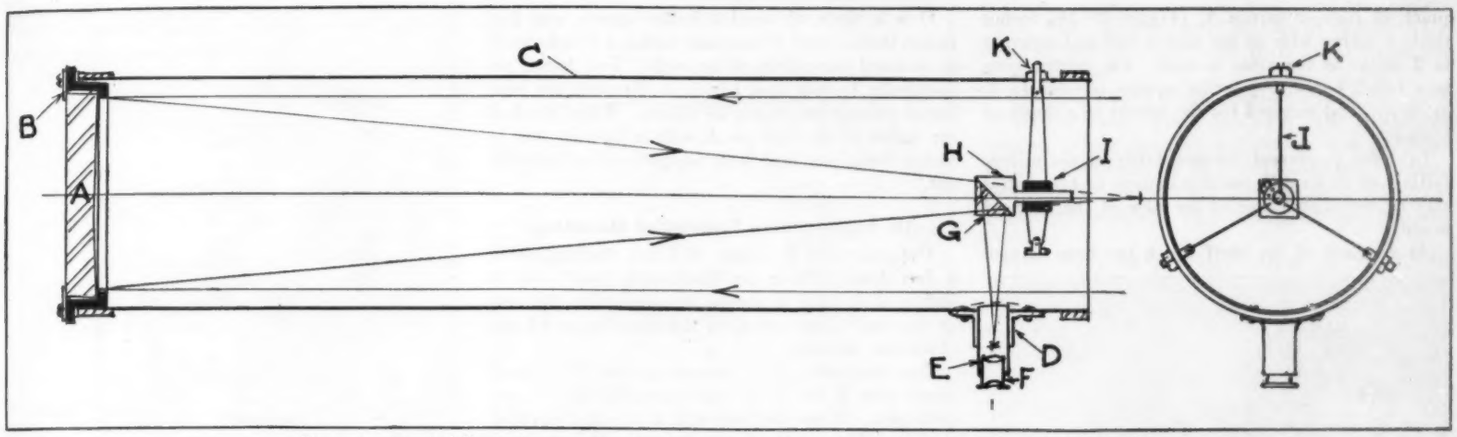
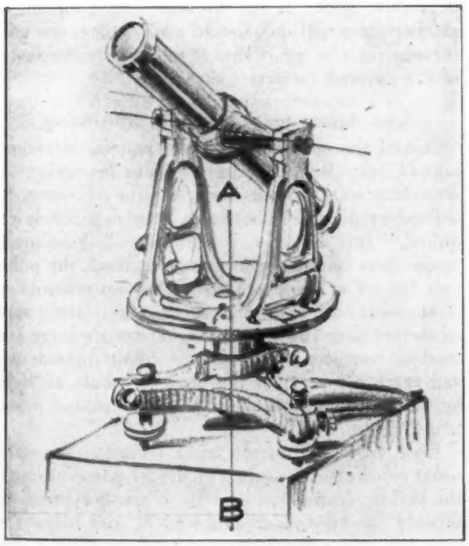


Figure 1: A typical Newtonian mounting, showing how the mirror, prism and eyepiece are attached and adjusted

which the earth rotates, I have drawn Figure 3. In this schematic diagram a mounting is shown placed on the earth's surface in about the middle latitude of the northern hemisphere. Its polar axis and the earth's axis are seen to be parallel to each other. At right angles to the polar axis is the declination axis about which the tube swings, allowing it to be pointed at any angle with the observer's horizon.

The earth, turning in the direction of the arrow, gives the stars an apparent motion in the heavens in the opposite direction, and a slow motion of the polar axis spindle of just the right amount will keep any star (regardless of its elevation above the horizon) constantly in view in the eyepiece of the



THE SURVEYOR'S TRANSIT

Figure 2A: Mounted as shown, the vertical axis is not parallel to that of the earth. But see Figure 2B

instrument. When the telescope is pointed toward the pole of the heavens, stars move slowly across the field of view. *Polaris*, for example, seems hardly to move during an entire evening. But, as the tube is swung down toward the celestial equator, the apparent motion of the stars is accelerated. Thus, the motion of the moon in a high-powered eyepiece is so rapid as to give an almost overwhelming realization that the earth is turning over in space.

Were the mounting to be erected at the poles, the polar axis would of course be *vertical* to the observer's horizon; if placed anywhere on the equator, it would be *horizontal*, or parallel to one's vision. In any case the polar axis of one's mounting makes an angle A with his northern horizon, equal to his latitude, for the two angles A, A are always the same, as is evident from the two triangles shown.

The most common type of mounting is known as the German mounting. The tube (Figure 4) fits into a ring A to which is attached a spindle B. The bearings C, C for this spindle are at one end of spindle D, and D's bearings, E, E are part of the casting fastened to the pier F. When D is adjusted by the screws G parallel to the earth's axis, any object in the telescope eyepiece will be held in the center of the field by revolving the instrument about D just fast enough to counteract the daily rotation of the earth.

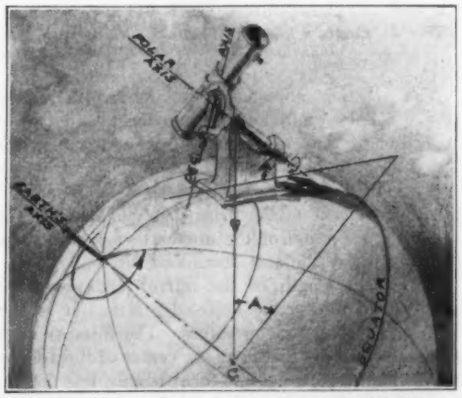
Four Common Types of Mountings

The German type of instrument is completely counterbalanced. The tube is gripped at such a point that it will remain pointing in any position without clamping. Since it overhangs one side of the polar axis, sufficient weight H is added to the opposite end of the declination spindle to bring the center of weight into the polar axis near its upper bearing. The total weight is, therefore, inside the base and is equipoised. Usually for convenience in following a star, a worm and worm wheel are provided on the polar spindle.

In the English or fork type (Figure 5) the tube is swung in a yoke attached to the upper end of the polar spindle, but considerably overhanging the pier. It has the advantage of requiring no additional counterweights.

This excessive overhang of the tube in the fork form is overcome in a third type (Figure 6) where the tube is brought within the two bearings of the polar axis, whose spindle is enlarged into a double yoke within which the telescope swings in declination.

However, all forms of mountings are compromises, and in this case the gain in rigidity is obtained at the cost of cutting off a part of the northern heavens.

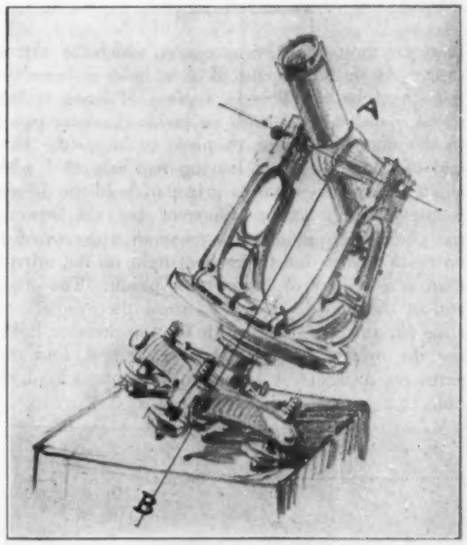


THE "WHY" OF THE EQUATORIAL MOUNTING

Figure 3: Its polar axis having been made parallel to that of the earth, the telescope will now follow the stars

This was the form adopted to carry our greatest of all mirrors, the 100-inch reflecting telescope at Mount Wilson, California.

Still another form of mounting is made by expanding the upper bearing of the polar axis to a large equatorial ring E (Figure 7) within which the telescope swings on its declination axis, the lower polar bearing being a thrust bearing at F. The large ring turns on the two rolls R, R. This mounting is very stable, the center of weight of the moving parts being well within the supporting rolls and thrust bearing. Part of the equatorial ring E is cut away in order to allow the tube to reach all parts of the heavens.



THE EQUATORIAL MOUNTING

Figure 2B: The transit of Figure 2A has been tilted. Its axis, A-B, is now parallel to the axis of the earth

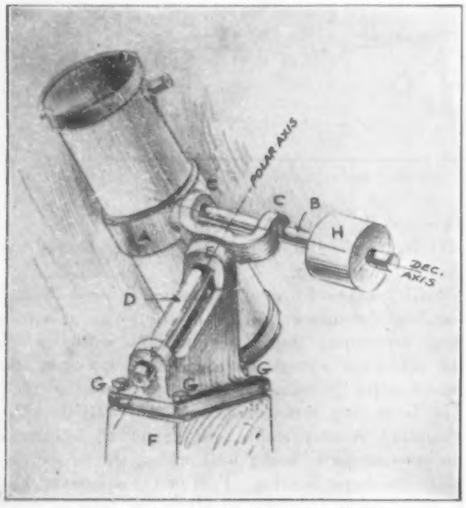
In all of these mountings considerable machining of parts is required, also special castings, running into amounts of money beyond the means and capabilities of most amateurs. The Springfield Telescope Makers selected the first of them, namely, the German form. But these men had access to the resources of the machine shops here and were all skilled mechanics. I shall, therefore, at the risk of possible criticism, describe a wooden equatorial mounting containing the essential features, but which may be easily put together from materials available anywhere. When the mirror maker has given his glass a good tryout with this mounting he will either be satisfied with it or will become so enthused with its performance, that he will attempt something better in metal.

To hold the optical parts, a clear straight-grained

plank of pine or spruce A, (Figure 8) 1½ inches thick, 6 inches wide at the mirror end and tapering to 2 inches at the other is used. The mirror rests in a 1-inch board, 6½ inches square, screwed to A, as shown, and recessed for the mirror to a depth of ½-inch.

In order to prevent the possibility of the mirror falling out of its cell, wooden buttons or brass clips may be distributed around the edge of the recessed board.

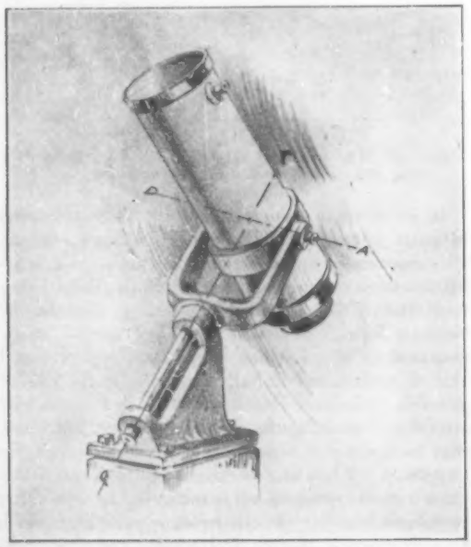
At the back of the shelf which has been formed



THE GERMAN TYPE OF MOUNTING

Figure 4: This is the commonest of the equatorial types. It has many advantages and comparatively few drawbacks

there are three adjusting screws on which the mirror rests. At the other end of A a hole is bored to take the tube C. This is a piece of brass tubing about 6 inches long, with an inside diameter equal to the diameter of the eyepiece to be used. One end of C is cut down, leaving two ears at I with enough spring in them to grip and hold the 1-inch totally-reflecting prism. Some of the tube between the plank and prism is cut away in order to offer no more obstruction to incident light on the mirror than is necessary to support the prism. The other end of the tube is slotted to allow the eyepiece to slide for focusing. So much for the member holding the optical parts. When assembled, find the point on A where it balances and bore a ½-inch hole.



THE ENGLISH OR FORK TYPE

Figure 5: It dispenses with counterweights but it is not as steady as some others, due to its long overhang

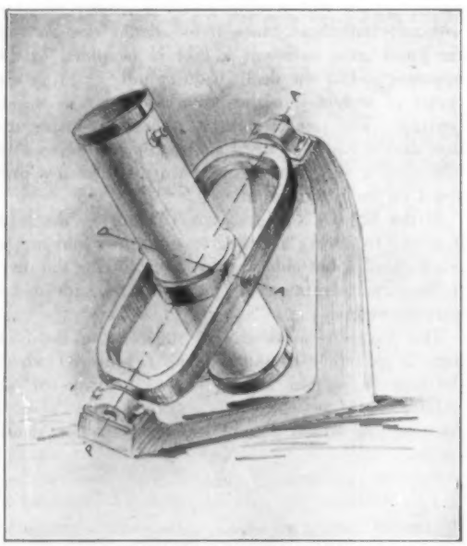
D is a block of wood 6 inches square, and 2½ inches thick. Part of one side within a 4-inch circle is recessed one-eighth of an inch. Two holes, respectively ½-inch and 1-inch in diameter are now bored through the block, as shown. When finished the latter is attached to A with a ½-inch bolt 4 inches long, provided with washers and a butterfly nut.

An Approximate Equatorial Mounting

The polar axis is a piece of 1-inch shafting about 2 feet long. Have the blacksmith bend over 6 inches of it until it makes an angle with the rest of the shaft about equal to the complement of the observers' latitude.

The remainder of the mount consists of a 2-inch steam pipe 2 feet long, cast vertically into a concrete pier. When the bent end is adjusted parallel to the earth's axis by lining it up on *Polaris* some evening, cement is poured into the steam pipe and allowed to set, the block D is dropped down over the shafting in the hold provided for it, and the mount is finished.

The butterfly nut will give the desired pressure between A and D so that the telescope will turn, but will remain fixed at any required declination. If D is slotted as shown, the wood screw M will take up any looseness of the bearing of the polar axis. The mirror is adjusted in its cell until its optical axis passes through the center of the prism J (Figure 8), and this is tested by placing the eye well behind the prism and noting whether the reflection of the prism is in the center of the mirror. Should it be found, say, at K, unscrewing the screw L will make the reflection move toward the center.

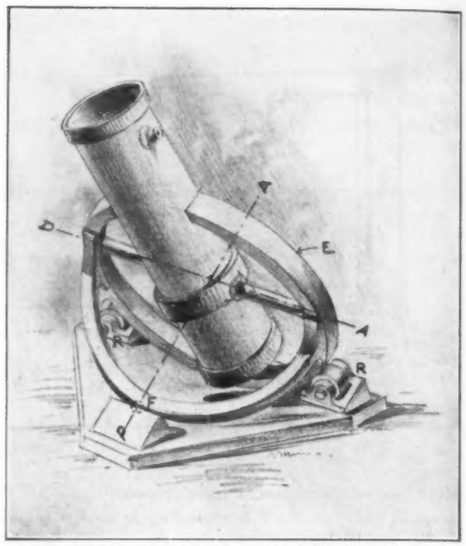


THE DOUBLE YOKE TYPE

Figure 6: Compare this with Figure 5. Having two bearings this type is very steady

The prism is adjusted by taking out the lenses of the eyepiece and looking into the adapter. The reflection of the mirror will be seen in the prism. The reflection of the prism should be central and must be made so by filing the seat of the prism. A slight movement of the prism between its ears will cause the reflection of the mirror to move and will indicate where the seat should be altered.

The focal length of the mirror has previously been found during the knife-edge tests. It is one-half of its radius of curvature. The distance from the surface of the mirror to the center of the adapter tube will therefore be this focal length, less the distance from the center of the prism to the focus of the eyepiece—(about 5 inches). For a glass of four feet focal length, the distance from mirror to adapter



THE EQUATORIAL RING MOUNTING

Figure 7: This type has many advantages, particularly that of steadiness. Here as elsewhere the polar axis is P—A

would be 48—5=43 inches. The focal plane of a negative eyepiece is somewhere between its component lenses; of a positive eyepiece it is just in front of the field lens.

The wooden part of the mount should be well painted and the polar axis should be kept slushed with hard grease. The wooden member can be lifted off the polar axis and taken indoors as a whole, for it is quite light. A cap of some sort (a piece of window glass will do) should always cover the mirror when not in use. This is to preserve the luster of the silvered surface.

The Accurate Springfield Mounting

One of the most convenient of equatorial mountings (Figures 9 and 10), and the one producing the most satisfactory results here, has the advantage of a fixed eyepiece. It is true, a second prism is required. This, however, permits the observer to sit in one position looking comfortably down the polar axis for all celestial objects. The two controls in right ascension and declination are within easy reach (see page 164), the setting circles are large and need no verniers. The tube is counterpoised and can reach all parts of the heavens. Loss of light by the additional reflection through a second prism is negligible.

Light from the mirror, after reflection from the usual prism A in the tube (Figure 9) passes through the hollow declination stud B, to another prism C, directly over the polar axis stud D, and below the eyepiece. In addition to its fixed eyepiece a distinctive feature of this mounting is the manner in which the two axes are maintained. Instead of two spindles held in bearings at their extremities, the bearing surfaces consist of large areas held together with small central studs, that of the declination axis being hollow. This arrangement permits very rigid forms to the three castings I, II and III. The setting circles c and d are cut on member II in convenient positions for reading.

Control in motion is as follows: the two tangent screws a and b (Figure 9) bear against spurs on the edges of two thin sheet steel discs inserted between castings I, II and III. Figure 10 shows the detail of slow motion about the polar axis. The spur on the periphery of disc D, bears in the circular groove C of screw B. Sufficient friction is maintained between the bearing surfaces of the discs so that not only will the tangent screws produce slow motion to either axis, but will also allow the telescope to be swung quickly through large arcs

of the heaven in both declination and right ascension. This arrangement makes a very good substitute for the expensive worm wheel drives.

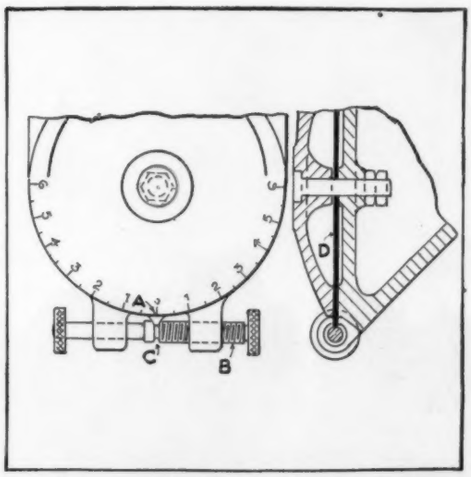
The Hartness, Turret Telescope

Of the many designs of mountings which enable the observer to sit in comfort in an enclosed and warmed room, space here forbids treatment. The most notable of these among amateurs is the Hartness turret, described in the Scientific American, March 9, 1912, in which the roof of the building, made of cast iron, rotates on rolls, carrying the optical parts and delivering the light from a ten-inch objective to an eyepiece inside the room. Bell, in his book, "The Telescope," describes this and several similar mountings.

Mention only, has been made here of the Newtonian reflecting telescope. There are, however, others, but they are not as practicable for the amateur as this type. In the Gregorian type a small, concave mirror just outside of the focus is substituted for the prism. It reflects the light from the mirror to a secondary focus lying behind the mirror, through a hole in the center of the glass. The Cassegrainian type is similar, except that it interposes a convex mirror just inside the focus. Both of these combinations greatly increase the virtual focal length of the mirror without increase of tube length, but they are useless for day work on terrestrial objects and they require the figuring of an additional optical surface.

With an equatorial mounting providing with setting circles one can select any celestial object (above the horizon) by looking it up in the Ephemeris and setting the circles to the correct declination and hour angle. One also sets his watch to running on star time. If he has made no blunder in his calculations and the instrument is in fair adjustment, the object will appear in the field of view of the eyepiece. It may be an obscure double star, or a nebula, or a cluster, or a comet, wholly invisible to the naked eye and impossible of locating in any other way. Thus the desirability of owning a mounting provided with circles is seen, if one wishes to delve into the great storehouse of hidden wonders above us.

On the other hand, the simple wooden mounting which I have described will enable one to pick up all of the apparent celestial bodies—the moon, planets, sun spots, bright double and multiple stars, two nebulae visible to the naked eye, and one or two star clusters.



HOW THE STARS ARE SLOWLY FOLLOWED

Figure 10: Detail of the slow motion, front and side elevations. This is a part of Figure 9

Care must be taken in observing the sun, for the mirror makes a powerful burning-glass. It works best for this purpose while still unsilvered, but if it is silvered, cover the glass with a cardboard in which an inch hole has been cut. The safest way is not to use the eye at the eyepiece but to project the sun's image on a card placed outside the eyepiece.

It is hoped that the amateurs will not copy these mountings slavishly, and partly for this reason set dimensions are not given except in a few instances. When controlled by a clear comprehension of the principles of the mountings used and some mechanical judgment, the exercise of the amateur's individuality in planning his telescope is highly desirable. This suggestion will, it is hoped, obviate the production of a large number of telescopes, as like as a lot of peas. For example, Mr. Clarendon Ions, of Miami, has built an ingenious equatorial mounting almost entirely from discarded parts of a Ford car.

Eyepieces or oculars for astronomical telescopes are usually the Hyghenian type in 1¼-inch tubes. Their powers vary according to their equivalent focal length *(e.f.l.)*. For our telescope of 4-foot focal length an eyepiece of 1-inch *e.f.l.* would give 48 magnifications (the focal length of the mirror divided by the equivalent focal length of the eyepiece). A ½-inch eyepiece would give 96 magnifications and a ¼-inch, 192 magnifications, respectively This makes a good battery of eyepieces for range of powers. They cost from about six to ten dollars apiece.

Were I to have but one eyepiece at first, it would be the low power, viz, 1-inch *e.f.l.* The Hyghenian eyepiece is not, however, achromatic, and the color is quite noticeable in a mirror telescope. I have used almost exclusively the Hastings, three-lens, positive oculars, which give a beautiful, flat and colorless field.

Eyepieces from old microscopes are not to be despised and they work very well with a mirror. They are usually of low power and are useful for terrestrial observation. It is not advised to use a higher power than ¼-inch *e.f.l.*, as the atmospheric disturbances and the quality of the mirror surface set a practical limit to the magnification.

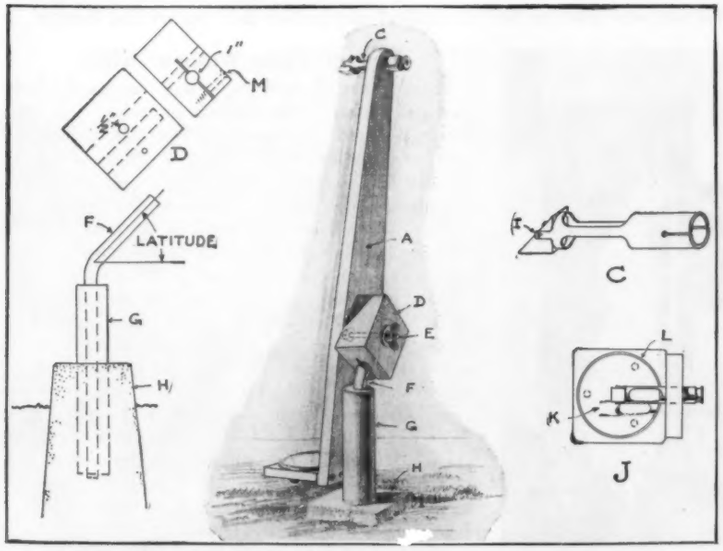
Literature and Materials

A finder is a small telescope fastened to the eyepiece end of the telescope as an aid in pointing the tube to any desired and visible object. They are undoubtedly a convenience in picking up a star quickly, although we usually get along here by sighting along the tube itself. Of course, with one's mounting provided with setting circles, in good adjustment, a finder is unnecessary.

Literature on mountings includes the following: "The Polar Reflecting Telescope," by R. W. Porter, *Popular Astronomy*, May, 1916. "The Enclosed Observing Room," by R. W. Porter, *Popular Astronomy*, May, 1917. "A New Form of Telescope Mounting," by R. W. Porter. "The Telescope," by Louis Bell. "The American Ephemeris and Nautical Almanac" (Supt. of Docs., Washington, D. C.) "The Amateur's Telescope," by Ellison (reprinted by the Scientific American Publishing Company).

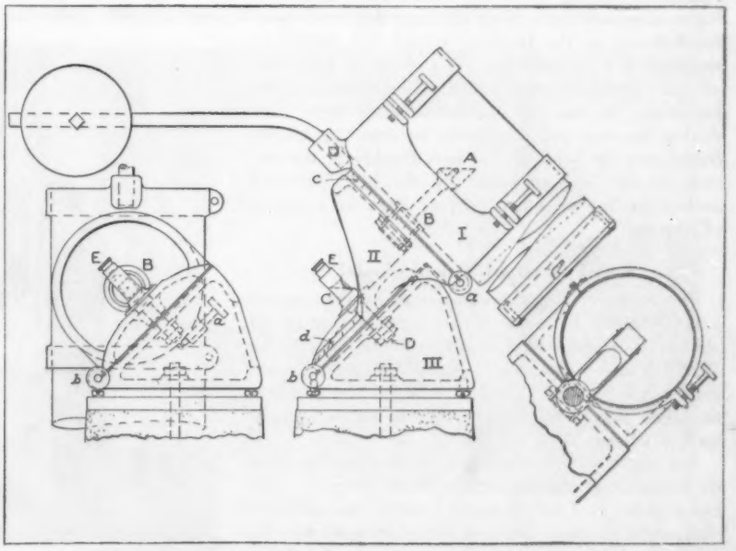
Materials may be obtained as follows: Prisms and eyepieces from the J. B. McDowell Company, 1954 Perrysville Avenue, Pittsburgh, Pennsylvania; also, the Spencer Lens Company, Buffalo, New York. Working blueprints of an equatorial mounting for a reflecting telescope with a fixed eyepiece; also prisms, eyepieces, from John M. Pierce, 11 Harvard Street, Springfield, Vermont.

Later in the year it is hoped that photographs of the various telescopes made by our readers, with their makers included, will be received for publication. With the publication of these pictures in view the individuality displayed should be of great interest.



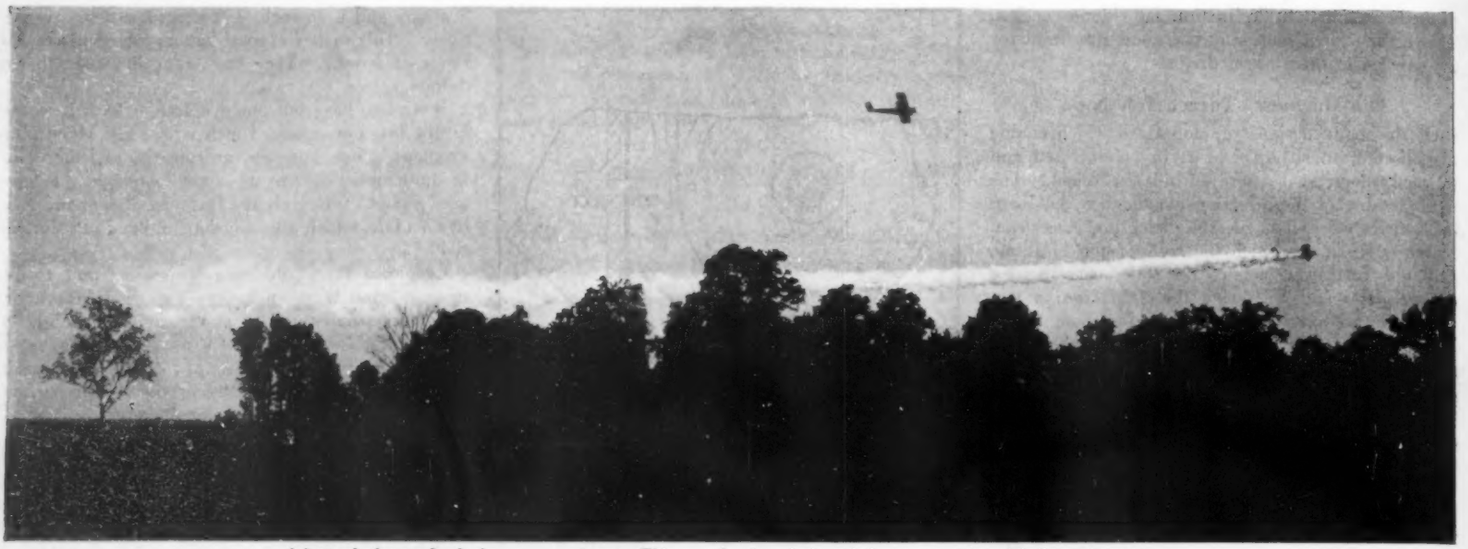
A WOODEN, EQUATORIAL MOUNTING THAT ANYONE CAN MAKE

Figure 8: A fair approximation of the equatorial type is obtained, simply by bending the metal shaft F, until it is roughly parallel with the earth's axis



TWO ELEVATIONS OF THE SPRINGFIELD, EQUATORIAL MOUNTING

Figure 9: This is the mounting shown on page 64 and on the cover. Since it is equipped with setting circles, a star may be located with the aid of the Ephemeris



Aviators laying a cloud of gas over a forest. This may be the solution of the gypsy-moth and boll-weevil problems

Peacetime Uses for "Poison Gas"

A Wartime Weapon Is Made to Serve Mankind

By D. H. Killeffer

Secretary, New York Section, American Chemical Society

IF you have boll weevils in your young cotton, a cold in your head, valuables to protect from bandits, mobs to disperse, or marine pilings that are being attacked by teredo worms, your best bet is to use "gas." In spite of the efforts of sentimentalists to consign chemical weapons—"poison gas"—utterly to the consuming fires of Tophet, peace is developing multitudes of valuable uses for them little, if any, less important than their service in battle. Both the materials and the methods used in the war between men and nations are proving of the utmost service in man's constant warfare against the pests and parasites which prey upon him and his works.

If such peace projects are to be discountenanced because they are of a nature readily convertible to wartime usage, with all the supposedly inhumane and cruel results, one must confess himself unwilling to approach the subject with any degree of open-mindedness, as the facts on record fail utterly to support such a contention. To obtain a true view of the facts, one must brush aside, as biased and interested, the various statements which were made during the war years in order to urge the United States into the conflict, and look frankly at the records of the war prepared by the best informed authorities for no other purpose than as a matter of history.

Gas Prevented Tuberculosis!

The report of American casualties by the surgeon general shows that some twenty-eight percent of all the injuries suffered by our soldiers during the World War were caused by gas alone, a not inconsiderable item when added to it is the fact that less than one percent of the cost of the war was spent on this weapon.

But the record further shows that only two men died out of every hundred injured by gas, while twenty-four died out of every hundred wounded by shot, shell, shrapnel, bayonet and other weapons. In other words, the man who became a casualty from gas had twelve times the chance of recovery that the one injured otherwise had. It is also important that, according to this record, only one man in 2,300—a vanishingly small proportion—of those gassed were permanently injured, while one in fourteen of those injured by other weapons, but not killed, lost at least an eye, an arm, a leg, or the use of one or more joints. Because it is most conveniently available these statistics are taken from the American casualty record. The data for the other armies engaged differ only slightly from these figures.

At the time of the Armistice, no one knew what would be the later effect of gassing on the men who had apparently recovered. Many of them were seriously warned to expect to die within five years, and others, that pulmonary tuberculosis would surely overtake them. The passage of time has shown conclusively that these well meant warnings were quite groundless and only served to disturb the minds of veterans. However, they were so fully believed that some 300,000 applications for aid were made to the Veterans' Bureau by men who believed themselves suffering from the delayed effects of gas, when the official records show that only some 70,000 American soldiers were gassed during the war seriously enough to need attention!

Chemical Warfare Service

A CURE FOR COLDS

Pulmonary disorders are treated in an air-tight chamber. The chlorine controlling device is under constant observation

No less authority than that of the surgeon general, supported and amplified by the sworn testimony of Dr. Albert P. Francine (medical consultant-in-gas with the Fourth Army Corps in France and an earnest student of post-war developments among gassed men), before the Select Committee of the Senate on Investigations of the United States Veterans' Bureau, states that far from causing tuberculosis, gas actually prevented it. In their statements that gas left no serious after-effects, both the surgeon general's official report and Dr. Francine's testimony were later fully confirmed, through their replies to a questionnaire on the subject which was widely distributed to medical men in both this country and Europe.

Few of These Weapons Killed

In the face of such facts, one can hardly hold that gas in war is the heinous invention it is commonly pictured. Nor need one fear that the development of peace uses of this weapon will lead us more quickly into war than the arming of our police and our hunters with deadly weapons of another sort.

The peace value of chemical warfare depends more especially upon the methods developed for war which are applicable to peace problems and to intensive study of poisonous and disagreeable materials. The ordinary term, "poison gas," applied to chemical weapons has led the majority of people to overlook two essential facts: few chemical weapons are actually lethal poisons, and even fewer of them are gases, surprising as it may seem. It is quite impossible to kill a man with the majority of chemical weapons because they so discomfort him that he will not stay in their vicinity long enough to get a fatal dose; and even if he were to do so, few of these weapons would kill.

Actual gases, however poisonous they may be, are seldom usable in the open—and the battlefield can scarcely be put under cover—because of their strong

tendency to dilute themselves rapidly in the surrounding air and thus prevent the building up of a high enough concentration to cause death. Of course, the first large-scale gas attack, against Ypres in April 1915, was made with an actual gas, chlorine. In spite of its apparent success against unprotected troops, the prompt development of masks to keep it out, coupled with its tremendous cost, when used in a cloud, led to the abandonment of this sort of attack.

Chlorine has been known and used in commerce in huge quantities for several decades. Our water supply is purified by it, our clothes are bleached by it and it has been—in the form of chloride of lime—one of our most valuable disinfectants. As a war gas it failed on account of the ease with which it could be kept out of the lungs of the soldiers. However, it soon was observed to have a very beneficial effect in keeping the nose, throat and lungs free from bacterial infection. Hence, a study of possible means of applying it war fashion was made. In very low concentrations in the air—little more than enough to smell easily—it has been found to prevent and cure colds, influenza, bronchial infections and even to reduce the dangers of tuberculosis. Here we have a definite argument against the widely cherished fears of gas as a cause of pulmonary disorders, for this one actually cures them. Last year (1924) many submitted to the chlorine treatment for colds and were easily cured.

Tear Gas Effective But Harmless

The method of treatment consists in having the patient sit in a chamber the air of which contains a faint trace of chlorine—0.02 milligrams per liter of air—for an hour or so. In a report of experiments along this line in the Journal of the American Medical Association, Drs. Vedder and Sawyer state that of 931 persons so treated for a variety of acute and chronic pulmonary complaints, including laryngitis, pharyngitis, bronchitis, whooping cough and influenza, 71.4 percent were completely cured and 23.4 percent were materially benefited.

Among those chemical weapons which are neither poison nor gas, "tear gas" is finding the widest use in peace for the identical purpose that made it valuable in war. A whole group of quite non-toxic materials were used in the war to affect certain parts of the human system and to make the soldier as uncomfortable as possible by forcing him to wear a gas mask which was hardly less uncomfortable than the tears, sneezing and vomiting it was intended to prevent. These agents were not intended to produce death, but rather to penetrate the mask and force its wearer to remove it, laying himself open to injury by poisonous materials sent over at the same time.

Chemical Warfare Service

A HAND GRENADE BURST

In this photograph, however, it is burst for the purpose of spreading disinfecting gases, not as a deadly weapon

Tear gas (cyanogen chloride, or C.N. for short) does nothing but produce a blinding irresistible flood of tears. Once started, nothing can stop them until the weeping eyes are entirely removed from the contaminated atmosphere, and in the meantime the victim is quite helplessly blind. After a few minutes (less than ten) in a clear atmosphere the tears and smarting stop and even the most skillful oculists cannot detect the slightest signs of permanent injury. Certainly the handling by machine and riot guns of mobs which refuse to be scared, is sure to result in injury to someone, while tear gas as it is used, mixed with smokeless powder in special, non-fragmenting hand grenades, developed for the purpose, in blank cartridges and in policemen's billies, cannot cause any permanent harm.

In addition to the police use of tear gas, jewelry establishments throughout the country are being equipped with apparatus for releasing it by the foot, which renders the bandit who may threaten robbery, as helpless as a babe. To the uninformed, gas has a great element of fear connected with it, as witness the prompt dispersion of the mobs in the Mingo mining district at the mere threat of its use.

At Austin, Texas, some months ago, the courthouse became so infested with bats, rats and their accompanying vermin as to threaten the dignity of the tribunals therein. Non-persistent, penetrating chemical weapons were used and, behold, the pests were no more. Ships' holds must frequently be so treated, and the only satisfactory fumigant which the public health service can find for this purpose is hydrocyanic acid, a deadly poisonous, almost odorless gas. It has the drawback, however, of giving no warning of its presence and many lives have been lost by men going into ships before the atmosphere has cleared. To correct this, small amounts of tear gas are generated now along with the highly toxic hydrocyanic acid and everyone is promptly warned of threatened danger by copious tears.

Its Use Successful Again Insect Pests

Two other types of pests are being fought by chemical weapons, the insects preying upon our vegetation and the teredo worm and other marine borers, which annually destroy immense numbers of wooden structures, ships and piers in salt water. The cotton boll weevil is, perhaps, the most destructive of the insect pests; and scores of others, the gypsy moth and the peach borer, particularly, destroy wealth in quantity. It is proposed to put these and their kind out of business by laying a cloud of poisonous smoke (a characteristic war trick) by airplane over the infested areas. Experiments so far indicate that greater success will be thus attained more cheaply than by present methods of spraying and dusting. It should be easily possible to kill the insects in vast fields and forests by such a method, once the details are worked out.

All the tribe of marine borers are refusing to touch experimental pieces of piling treated with some of the near relatives of the war gas, Lewisite. Chlorovinyl-arsenious oxide and phenyl-arsenious oxide are proving more effective in protecting wooden submarine structures than any of the treatments now in use.

No discussion of the peacetime activities in gas research could be complete without mention of the defense that has been developed against carbon monoxide (probably the most deadly of all to man), hydrocyanic acid, chlorine, ammonia, sulfur dioxide and a number of others which frequently kill perfectly peaceable men. Carbon monoxide is present in city gas and kills quickly without warning. The development of a gas mask to keep it out was a difficult problem but it has at last been solved, a reasonably comfortable mask devised, and an efficient absorbent found. All the other ordinary gases can be kept out and the lives of many public servants (firemen and miners especially) can thus be saved.

Chemical Warfare Service

A TRAVELING DISPENSARY

Several of these units for the treatment of colds, et cetera, with chlorine are now being operated by the Red Cross. Such a service would be particularly effective during epidemics

Pacific & Atlantic

A PEACETIME GAS ATTACK

Workmen putting the finishing touches on a tennis court in Hollywood, California, using chemicals that produce a deadly gas. Twenty minutes only can the men work continuously

Telephoning Beneath the Sea

Using Sound Waves Above the Audible Frequency, the Navy Has Developed a New Way to Telephone Secretly Through the Water from Ship to Ship

By Nell Ray Clarke

FOR the first time in history a submarine telephone has been perfected which gives real promise of direct and uninterrupted communication between submerged submarines, between a submerged vessel and a ship on the surface, or between a submarine and a shore station.

It is not a radio device; it has nothing to do with radio. It is a reversion to the principle of the telephone pure and simple—the transmission of voice by sound waves.

Submarines cannot be very effective until they are able to talk to each other and thereby co-ordinate their battle maneuvers. They have been hampered always by having to work singly or out from a shore base or from a mother ship.

Heretofore, all devices for direct underwater communication have been failures. Submarines have been able only to rise to the surface of the water and receive radio signals from such powerful stations as Arlington Radio Station. Long wavelengths can penetrate the water to a depth of from 20 to 30 feet, but short waves cannot be received. Furthermore, the submarine was unable to answer the communication,—a very serious handicap—because it is impossible to tsansmit electrical energy from submerged antennas on account of the high electrical conductivity of salt water.

If the new apparatus perfected at the Naval Research Station, Belleview, D. C., proves as effective for long distances under the ocean as it has already proved for two-mile distances beneath the Potomac River, the officer in his cabin can simply pick up a telephone exactly like the one on your desk and talk to the commanding officer of another submarine with as much ease as you talk to a friend a few city blocks away.

Making Inaudible Waves Audible

The idea on which the instruments are based is not new; scientists have been working unsuccessfully along the same lines for years, but they have always tried working with audible sound waves—the same sound waves that are used in voice transmission by land.

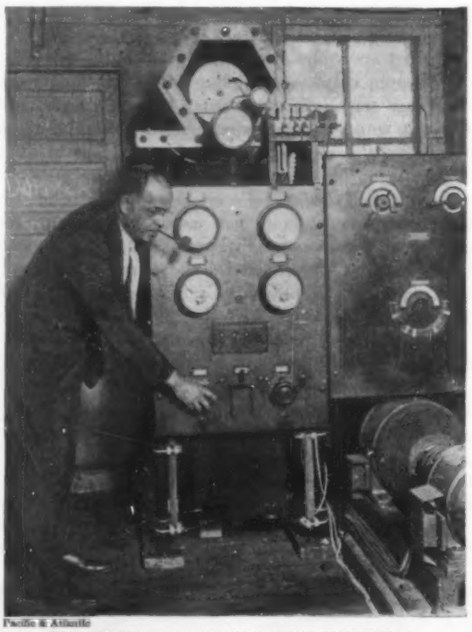
One of the scientists of the Naval Research Station then decided he would try the inaudible sounds. He began experimenting with the short waves, or the "supersonics," as they are now familiarly called in the Navy Department. To his astonishment and delight he found that these waves could be directed. He devised a telephone by means of which the voice sounds are transmitted on the supersonics from one vessel to the other and then are superimposed on audible waves, or heterodyned, at the other end and are then heard through the ordinary telephone instrument.

He has now perfected his instruments to a point where it is possible to direct these very high-pitched sounds in a beam which can be turned in any direction, as we do the beam of a searchlight, and therefore, in the particular direction of the vessel with which he wishes to communicate.

The chief advantages of this type of sound telephone over any previous means of underwater communication are: 1. Nobody or no ship can hear the message except the one toward which it is directed. The element of secrecy thereby provided is immediately evident. 2. By putting on several transmitters, a submarine can talk to a fleet of submarines at one time and plan an active campaign and even serve as headquarters from which operations can be directed.

But, in order to do this, the instruments must be tuned to one another. That means that the United States will have all its subsea telephones tuned to a certain wavelength, which is done when the instrument is made. This is a mechanical tuning. The instruments will send only one wavelength and receive only one.

As long as the wavelength on which the instrument operates is kept secret, there will be no danger of an enemy submarine tuning in to catch the messages. And even should an enemy find out the wavelength, enemy vessels would have to be equipped with the apparatus for receiving the message at such a time as it might get into the direct beam of the sound—a situation which might happen, but is not probable.



Pacific & Atlantic

DR. HARVEY C. HAYES, THE INVENTOR

A closeup of the electrical apparatus for transmitting the voice from one point to another under the water, as it would appear set up in the submarine

Experiments now being conducted at the Naval Research Station hold out an alluring future for the instruments. The apparatus is simple and inoffensive looking. The same harmless transmitter, which resembles the top of a fireless cooker, is also used for the receiving disk. It is made of two circular plates, each being about as large around as a saucer. Between them are thin sheets of quartz crystal of the Piezo-electric type. The plates are mounted in a circular piece of steel, which in turn is mounted in the end of an iron container, a pipe-like affair on the bottom of the ship or on the side of the submarine, so that it comes directly in contact with the water.

Electric wires, carrying an alternating high-frequency current, pass through the pipe and are attached to the steeel plates. When the current is sent over the wires, the quartz between the plates expands and contracts and sets the disks in motion just a little.

It is these small movements of the disk which send out through the water the super-sound waves. A receiving instrument exactly like the transmitter on the other vessel to which the communication is addressed vibrates in sympathy with the wave and sets up a current in the instrument, which is heterodyned down to a wave the human ear can hear.

Up to the present time, the instruments have not been tried out on submarines, but experiments are being conducted from two barges which have been towed out in the Potomac for the tests. Not only have the men been able to talk to each other at distances of two miles or more, but every quality of the voices is reproduced perfectly. In transmitting, the carrier sound wave is modified by voice inflections and the modifications come back through the detector.

To make assurance of the reproductive quality of the instruments doubly sure, the men have played phonograph records near the instruments, choosing the most difficult operatic selections, but the selections have come over as perfectly as if the phonograph were in the same room.

The high-power vacuum tubes, commonly used to supply energy in radio transmission, are being used for the alternating high-speed current, and the telephoning is being done at a pitch of 120,000 kilocycles. This is astonishing in view of the fact that the human ear can ordinarily hear only the sounds at a pitch of from 30 to 30,000 kilocycles.

There seems to be only one kink in the new method that may give trouble, and that is due to the fact that sound waves travel much more slowly than radio waves. It takes a sound wave in water five seconds to travel four miles.

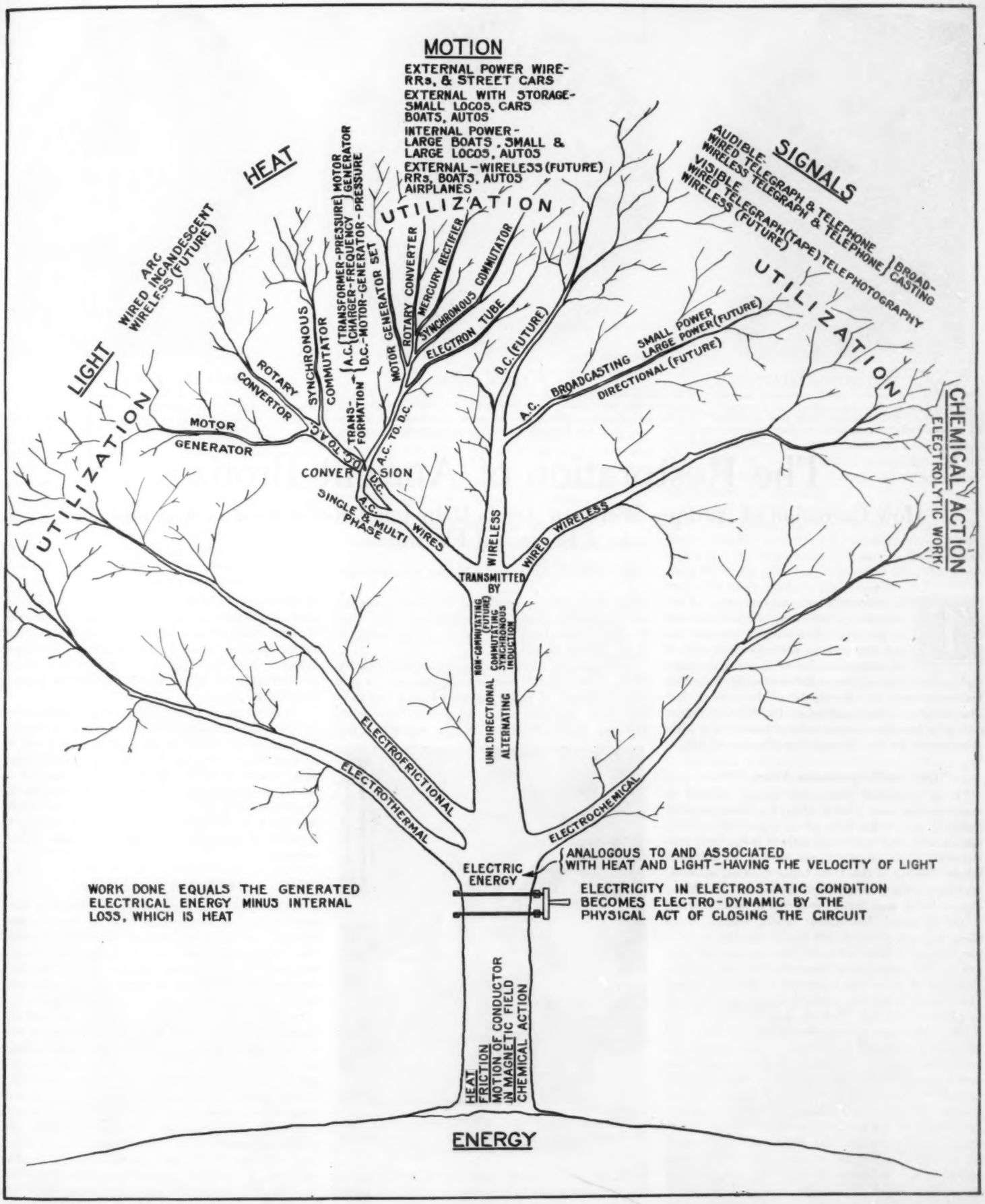
Short Waves Solve the Problem

The real secret of the invention lies in the peculiar behavior of short sound waves as distinguished from the long ones. Waves always have the tendency to travel out in every direction from a diaphragm. In using the instruments of the Fessenden-oscillator type, previously thought to offer the solution of the underseas communications problem, long sound waves are sent out in every direction, but upon coming in contact with the irregular ocean bottom they are reflected back in echoes to the instrument which sent them out.

These echoes of the original signal become so confounded with each other that there seems to be no possibility of interpreting a message. For instance, if an operator sent out a dot and a dash, he probably would get from five to eight or more echoes of each sound. Before all the dots came in, the dashes would begin coming in.

The short waves—and by short waves, always is meant short with respect to the diameter of the transmitter—also travel out spherically from the oscillator, but they have a tendency to neutralize each other, a fact well known to students of the action of sound waves. As a result, those which travel out from the steel disks in straight, parallel lines are the only ones left to transmit the sound, and it is these waves which make a beam that can be directed.

The audible waves, on the other hand, due to the distance between their crests as compared with the dimensions of the sending apparatus, do not neutralize each other so readily.



Compiled by L. S. Treadwell, Associate Editor Scientific American

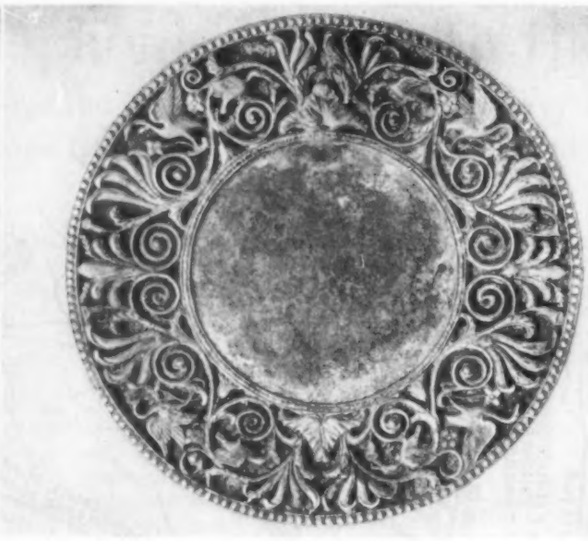
A Tree of Electricity

It is impossible to clearly delineate all the ramifications of electricity. We give, therefore, only the principal applications to show their inter-relation

Photographs courtesy of the Metropolitan Museum of Art

BRONZE STRIP BEFORE TREATMENT

A part of a decorative panel, completely mineralized, yielded to electrical treatment with astonishing results. Dilute caustic soda and electricity reduced the outer coating to sponge copper



A GREEK MIRROR

This mirror was submitted to microscopic and other tests to determine its genuineness. On the basis of these examinations it was concluded that the mirror was of ancient origin. The mirror was at one time fastened to a wooden backing. The frame was protected by a thin layer of gold

BRONZE STRIP AFTER TREATMENT

After the rough bronze shown on the left was treated by electricity, the sponge copper was removed with nitric acid, showing the gold leaf, one-tenth the thickness of a human hair

The Restoration of Ancient Bronzes

How Corrosion of Antique Works of Art Is Halted and Restoration Is Accomplished by a Process of Electrolysis

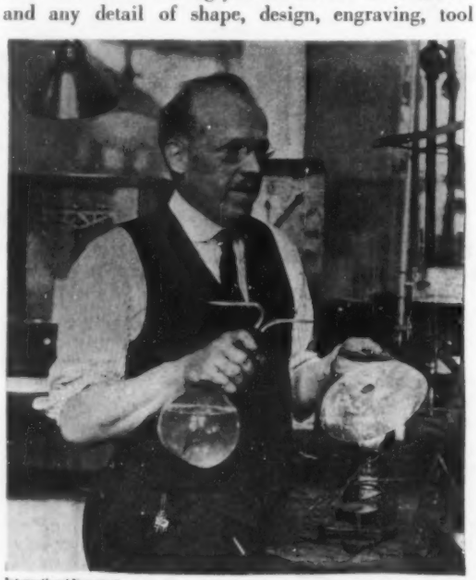
By Colin G. Fink and Charles H. Eldridge

THE restoration of antique works of art has always been more or less shrouded in mystery. Fortunately, however, we are now able to present a new method of restoration, based on scientific principles, the result of the collaboration of Columbia University and the Metropolitan Museum of Art. The director of that institution, Dr. Edward Robinson, goes into the general subject briefly in a pamphlet issued by the Metropolitan Museum of Art:

"Diseased" Specimens Affect Others

"It is a general impression among visitors to museums that once a work of art has been properly installed, once it has been set on a pedestal or hung upon a wall, and more especially if it has been protected by glass, its life is assured for an indefinite future. So far is this from being the fact, however, that exactly the contrary might almost be true. Many objects bring with them the germs of deterioration, if not of actual destruction; others, though sound when they are received, are highly sensitive to relative degrees of heat and cold, moisture and dryness, and to the atmospheric impurities of our modern cities, never so serious a menace as they are today. These dangers are not confined to any one material or class of material. Indeed, there are very few—if any—which can be regarded as immune from one or another of them; and when we add to this the knowledge that one 'diseased' specimen in a showcase may and frequently does infect others, it will be realized that eternal vigilance is the price at which a curator keeps his collections in condition, though he is often at his wit's end to know how to arrest or prevent the disaster with which he finds himself threatened. One is the corrosive green crust with which objects in bronze or other copper alloys are apt to become thickly coated through long burial in the earth, and which not only completely hides the details of the modeling and the engraved designs, but frequently eats deeply into the surface of the metal itself, thereby rendering the object valueless, and sometimes destroying it altogether. The other is what is now familiarly known among collectors as the 'bronze disease.'"

We began our studies and experiments in January, 1923. The object of our investigation was to start with specimens of badly corroded bronze and to so treat them that the ugly crust should be removed and any detail of shape, design, engraving, tool mark, or other signs of workmanship remaining on the specimen might be restored or preserved intact.



International Newsreel

DR. COLIN G. FINK IN HIS LABORATORY

He is the discoverer of a new method of restoring antique bronzes and silver by electro-chemistry

It is generally conceded today that the corrosion of metals and alloys is due to an electrolytic process; and it occurred to us that if this electrolytic process of corrosion could be reversed, a method might be devised whereby the metal compounds in the crust would be reduced back to metal. This line of attack of the problem seemed most hopeful, since other methods, such as dipping the bronze into strong mineral acids, are far too radical and seldom produce satisfactory results.

It will be appreciated at once that any acid method is very difficult to apply, since it is almost impossible to regulate the action of the acid in such a way as to avoid the pitting of the underlying metal when such exists. Furthermore, the metal contained in the compounds of the incrustation is removed by the acid, whereas in the ideal case it should be reduced and put back into place. In the case of completely mineralized objects, acid would destroy them beyond redemption.

Object Made Cathode

We have given a large variety of methods a most careful trial and observed the results. We very soon decided in favor of an electrolytic method of attack. The fundamental idea was to replace cathodically the metal that had passed into the crust rather than to completely eliminate the crust with its metal content by corrosive acids or by mechanical means.

In developing our electrolytic process we tried out various electrolytes used by earlier workers, as well as other electrolytes suggested by our own laboratory observations. We finally decided upon a two percent solution of caustic soda as the safest electrolyte to use. Finkener's electrolyte of two percent potassium cyanide was found to be unsatisfactory.

Without any preliminary cleaning, the bronze object to be treated is hung as cathode (as will be explained below) in the two percent caustic soda solution, and a low amperage direct current is applied. The object is suspended with soft copper wires and is completely immersed in the solution. In case the object is very soft and fragile or is completely mineralized, fine, annealed copper wire is wrapped

COPPER TRAY BEFORE RESTORATION

This tray was about six inches in diameter. It was corroded and covered with a hard green crust

around the object, one to two turns per inch, and electrical connections are made with several turns of this wire. The anodes are hung on either side of the object. (The anodes are the poles or electrodes at which oxygen gas is evolved during the passage of the current.) Iron, duriron, and platinum anodes have been used with success. A rectangular glass battery jar with a capacity of one and one-half quarts serves well as a container for the treatment of small bronzes. For large objects we have used stoneware tanks; and there is no objection to the use of large tanks made of heavy sheet iron welded at the joints. The object being treated is always made the cathode—that is, that pole or electrode at which copper, gold, silver or other metal is deposited during passage of the current.

The action of the electrolysis is to precipitate metal at the cathode and to reduce the crust to finely divided or spongy copper. If the cell is operated for a longer time a compact deposit of metal is obtained. If the object treated originally had a hard metal surface under a thin sandy layer of crust, we may remove the reduced copper film or layer by a gentle brushing with a stiff bristle brush or soft brass-wire brush. The first step in each case is to submit the object to a very careful examination. It is measured and weighed; the crust of patina is studied and analyzed to get an estimate of the probable composition of the underlying base.

In the course of our investigations on ancient bronzes, we have had occasion to examine a number of objects concerning which there was some uncertainty as to whether or not they were genuine antiques. It need hardly be mentioned that there are a large number of spurious antiques sold to people who are not familiar with even the simplest means of determining the composition and age of the object.

Just as there are means and methods of detecting a counterfeit "Rembrandt," so likewise are there methods of detecting an imitation or spurious "antique" bronze. Although it is true that absolute identification of the fraud is not always possible, in the large majority of cases we can, by a systematic method of physical, chemical, and metallographic analysis, determine whether or not the bronze or other alloy is of comparatively recent origin.

We have divided our method of investigation and procedure into three distinct steps:

1. Microscopical examination of the patina or crust.
2. Metallographic examination of the metal core.
3. Chemical analysis of the metal.

In the examination of the patina we may find distinct crystalline growths of malachite or azurite, the tiny crystals partially imbedded in the underlying oxide film. Such crystalline growths are most difficult to imitate and patinas of recent origin are almost always amorphous or non-crystalline. Nevertheless, the patina may be recently formed or applied and yet the bronze may be genuine—in fact, very many of the genuine bronzes exhibited nowadays have patinas of recent or artificial formation.

Corrosion Products in Layers

Accordingly, if the microstructure of the malachite or azurite particles in the crust or in the patina is distinctly crystalline and interlaced with the copper oxide layer, the bronze is very likely genuine. But an amorphous malachite deposit does not necessarily imply that the underlying bronze is not genuine.

Under the outermost coating of malachite or azurite or clayey material, there usually is found, in the case of genuine bronzes, a layer of copper oxide, reddish-brown to reddish-black in color. It is usually of considerable thickness and is not readily applied by any rapid artificial process. Furthermore, very often the products of corrosion are imbedded deeply in the metal next the crust.

In the metallographic examination of the bronze we find additional proof as to whether or not the bronze is genuine. Taking a very fine slice of metal from some inconspicuous part of the bronze, and preparing this by polishing and etching for microscopical examination, we noted in the case of a genuine bronze that there is a gradual change in structure as we pass to the outer exposed edge of the bronze; furthermore we sometimes noted changes in the size of certain crystal components of the bronze, changes that are brought about by a very slow process of "annealing."

COPPER TRAY AFTER RESTORATION

After electrolytic reduction and restoration, the design engraved on the copper was revealed almost completely

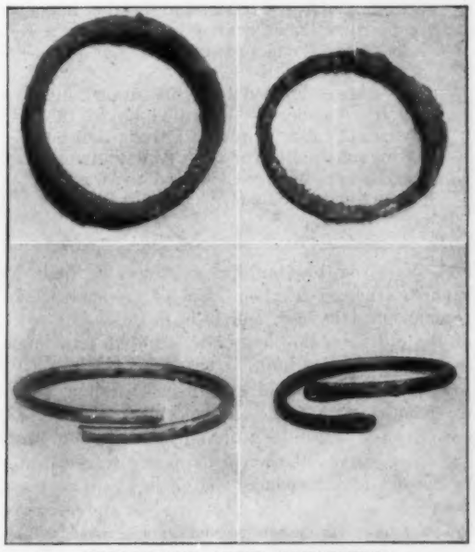
Chemical analysis must be carried out with great care. The results may support the findings of the metallographic investigation by determining chemically that the main body or interior of the bronze has a decidedly different composition from the layers under the outer oxide or patina surface.

In conclusion we would like to quote from Dr. Robinson's introduction to the museum pamphlet:

"We are now well on the way to salvaging brilliantly thousands of bronzes which might otherwise have been ruined by crude attempts at 'cleaning' or discarded altogether as worthless. The artificial patination of such objects as may require it after treatment, and the cure or prevention of the bronze disease, still call for further study; but considerable progress has been made in both, and we are justified in believing that satisfactory solutions are not far distant. The museum official or collector who hopes to find in this report a ready-made formula for treating bronzes which anybody can apply will be disappointed. While Dr. Fink and Mr. Eldridge have shown that ancient bronzes can be cleaned and preserved, they have demonstrated with equal force that this can be done only by a highly trained expert who watches and deals instantly with every symptom that develops during his treatment.

A GREEK BRONZE GOAT

This little bronze goat was covered with a hard gray-green crust. The fore feet were encrusted and cemented together



BEFORE AND AFTER TREATMENT

LEFT: *A bracelet of round silver alloy wire.* RIGHT: *An oval bronze bracelet with snakes' heads at the ends*

THE BRONZE GOAT RESTORED

The goat was submitted for three days to the electrolytic process, which restored it to the condition shown above

TWO EXAMPLES OF PISE HOUSES OVER 150 YEARS OLD

This house built in 1773 of rammed earth is now standing at 13th Street and Rhode Island Avenue, Washington, D. C.

Built in 1773, the owner attempted to demolish it. The walls were so hard that they were retained in the remodeled structure

More Mud Houses

An Ancient Method of Building Which Has Been Revived in Europe and is Now Being Put to Good Use in America

By Karl J. Ellington

Photographs by Courtesy of the Author

IN North Africa whole cities are built with pisé — rammed earth. The Moors brought the method into Spain, where we find the many centuries old Alhambra palace (Granada) is built in some parts of this material. The Romans knew and used the method. In Southern France old pisé houses are plentiful, and it is from France we have the term *Pisé de Terre*, commonly shortened to *pisé*.

We have some old buildings here in America, in fact it is quite probable that the pisé method was in use on the American continent earlier than in any other part of the globe. In Central and South America the pre-historic races have left some remarkable architectural creations, among which can be found proof that these people also knew how to build terraces and buildings with rammed earth. To this class of buildings, no doubt, belong the Casa Grande ruins, Arizona. In 1632 this ruin was six stories high and the Government is now preserving what remains of it. The Indians at that time had no legends as to who constructed it. To many it is a puzzle by what method the Casa Grande was built. But the markings of pisé forms can still be seen, and we are sure at least, that that method was used in its construction.

Walls Hard as Stone

To us it is of more practical value, however, to find that some of the early colonists knew how to build with rammed earth. One of the oldest houses in America is a building of this construction in St. Augustine, Florida. It is established that it was built in 1556. Another old pisé building has been found in Washington, D. C. According to preserved documents it dates from 1773. A few years ago the present owner of this house attempted to wreck it, needing the space for a more modern building. The wrecking had to be given up, however, because the walls were found to be as hard as stone. It would be an expensive process to completely demolish them. So, the house was remodeled and the exterior refinished with white pebble dash.

Similarly constructed buildings are said to exist at various places in the south, or where the colonists had come from pisé-building provinces in Spain or France. Thomas Jefferson knew of the method and recommended its use, and it is thought that some of the old farm buildings near the Jefferson home in Virginia are so built.

A Way to Lower Building Costs

In our April 1924 issue we described the revival in America of the art of building houses out of ordinary earth—the so-called Pisé method. A large number of inquiries came in requesting more particulars. These were referred to Mr. Karl J. Ellington who has had much to do with introducing this method into the Scandinavian countries and is the one responsible for its revival here. He tells here of the development which our first article predicted.

We are convinced that when Americans are more generally informed as to the virtues of the Pisé method, there will be springing up all over the country attractive homes, built well within the means of the average citizen.

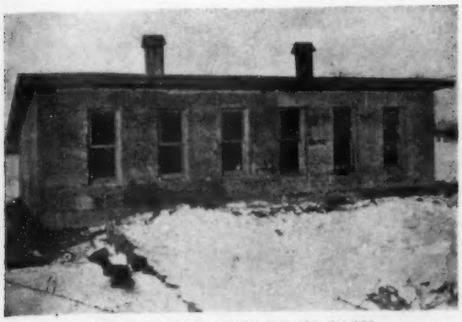
The first studies and experiments were made in this country many years ago, but only a few hundred inquiries and very little building resulted up to 1920. Just after the war the writer happened to be visiting in Europe, and introduced the method into the four Scandinavian countries. In Sweden and Norway now are to be found fine residences and even factory buildings as far north as the polar circle. These buildings have stood the severe winters up there for many years and prove that a pisé wall is practically as good under the midnight sun as on the equator, so far as its wearing qualities are concerned.

This revival in Europe has been mentioned occasionally in newspapers in America and a few individuals became interested and sought more information on the subject. Some two thousand inquiries have been received by the writer from all parts of the country, while several hundred have already made the first venture or are now building. Notable among these are a beautiful and luxurious home in Kansas City and a fine residence in Washington, D. C., of which we give a photograph. In Rockford, Illinois, is a small house that is so successful, work is now proceeding on a dwelling house. Another successful building is in Newcastle, Indiana. In Brunswick, Minnesota, a small house was built last year and a larger one is being erected this year—all by the pisé method.

Good for Hundreds of Years

Several hundred settlers and farmers in Canada are also building with rammed earth. They usually start with a chicken house, garage or barn and build the living houses after having more facility in handling the material. In every case the trial building has been so successful that large buildings follow. In the adobe-building states, many home builders are finding the pisé method far superior to the old way both as to time saving and the final result. On the Pacific Coast many are preparing to build this summer. The method and material harmonizes well with the architectural traditions grown out of the early Spanish culture in these parts, with its missions and haciendas, and occasional touches borrowed from the venerable pueblo creations.

That this type of house is the most healthful kind to live in, can be abundantly proven to anyone who will care to investigate or listen to the evidence. The investigator will also find that such a house will remain good for hundreds of years—practically



FOR A SMALL OUTLAY IN CASH

this henhouse was the sensation of Kanabec County, Minnesota, last year. The curious traveled miles to see it and many similar "coops" were patterned thereafter

A GOOD TYPE TO START WITH

The first attempt at pisé building is usually a structure of this kind. When facility is attained, larger buildings follow

THE OWNER BUILT THIS HIMSELF

To build this bungalow at Costa Mesa, California, dirt from the cellar excavation, with barbed wire reinforcement was used upon a concrete foundation

indestructible; that in fact the rammed earth wall will become stronger and harder with greater age, owing to the chemical action of weathering. As for foundation, many architects regard basements as an old-fashioned extravagance, and many a housekeeper has found running up and down stairs to and from the cellar an irksome part of the day's work.

A Cellar Above Ground

In building with pisé we have one more good reason for discarding the old style basement, since the best kind of a cellar, if wanted, can be built above ground and conveniently located near the kitchen or even connected with the same. In this way the rammed earth wall also obtains minimum cost even for the foundation, for in some localities there will be natural stone near at hand to use, and a little cement will be needed on top only, on which to spread the damp-proof course. Thus, the expense of excavation will be eliminated.

It is of importance that this method be taken up by farmers and settlers. There the conditions are most favorable for getting buildings at very small outlay in cash. Whatever will reduce the farmer's expenses will enable him to sell foodstuffs at lower prices. Lower building costs will also help many young men to choose farming instead of the city. Next to farmers and settlers, all people who want to live in suburbs or in country homes ought to know how to build their homes with the soil on the building site.

Our pisé house is not only cheap to build, healthy to live in—cool in summer and warm in winter—money-saving as to upkeep, fuel, insurance, doctor's bills, and so on, but it is also a house that will last forever, and, if built right, will withstand even the severest storms and cyclones. This, of course, is an important consideration in our middle western states —Ohio, Kansas, Nebraska, and so on.

Great Saving in Maintenance

If it were commonly known that the very best kind of dwellings and other buildings can be built with rammed earth, and if the method were utilized wherever conditions would warrant its use, it would mean a saving of millions every year in reduced building costs, maintenance and insurance. And this is only the financial side of it. It would mean to have at hand a building system that would enable every American family to live in a home of its own, without a cloud of debt overhanging. This freedom from obligation to the rent man would contribute much to the happiness of independence-loving Americans.

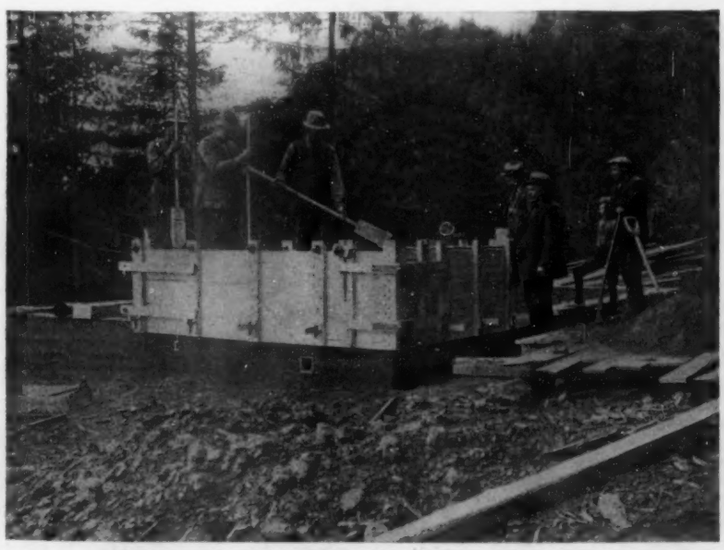
That by this method a house can be built at much lower cost than with any other material is self-evident, since the soil to build with, is already on the building site and free of cost even for freight. This soil requires no special treatment, and the implements needed—a movable form and three rammers—can be made by the self-builder in his own yard.

A good demonstration of the utility of pisé on the coast is a bungalow recently built in Costa Mesa, California, a photograph of which we give. This building is thirty feet by twenty-nine feet with five rooms and bathroom, also hall and porch. The owner is not a builder by trade and knew nothing about it except what he learned from the book, "Modern Pisé Building." No other help or guidance was needed. The method is for self-builders. There are a hundred details to be observed and none of them can be ignored, but they are all easy to understand. Any man with ordinary intelligence can follow them and do as well, but no one should attempt to build with rammed earth with fragmentary information, for pisé building is as much an art as any other method of building, and many of the seemingly fine points are essential to complete success.

Opens Up Unlimited Possibilities

The writer has a pisé home, now under way. The cellar will be above ground near the kitchen. For smoke channels, drainage pipes rammed into the walls make brick and masonry superfluous. Rammed earth will be used for the floors with open space between the ground and the floor, so it will be completely dry. Round pillars of great strength and some other stunts in pisé are features already tried out. The next experiment will be a good, tight and cheap roof made principally of compressed soil. Here there are a few problems in stresses that must be solved.

Pisé building opens up unlimited possibilities and, though it has passed the experimental stage, there still remain numberless effects of architectural beauty and utility to be perfected.



FORMS USED FOR BUILDING WITH RAMMED EARTH

The author stands in the right foreground directing construction of a demonstration building

LIKE ANY OTHER MODERN TYPE OF HOME

A completely modern house recently constructed in the suburbs of Washington, D. C.

Boring Galloway

A VIEW OF THE OLD KIMBERLEY MINE, SOUTH AFRICA

This mine has been worked to a depth of two thousand feet. The great open pit would hold a mountain

The Art of Cutting Diamonds

How the Rough Stone Is Cut, Sawed and Polished to Produce the Most Brilliant of Jewels

By Albert A. Hopkins

NOT so very long ago, we read in our old geography text book the sentence, "Amsterdam is noted as the center of the diamond-cutting industry of the world." The statement is true no longer. Today, America leads the world in the value of diamonds cut within her borders; and of all her cities New York glitters most brilliantly with these precious stones of her own cutting.

It has been estimated that all known diamonds represent a value of five billion dollars. In other words, these stones approach the value of all the gold accumulated in the world, which amounts to something less than eight billion dollars.

GETTING THE STONES READY FOR CUTTING

Before the diamonds are split or sawed the stones are marked to show where the cuts should be made

Most of these diamonds come from South Africa, about ninety million carats having been mined there. Brazil has produced fifteen million carats, southwestern Africa, five million, and India two million. The total output of all the other diamond-producing countries is less than two million carats. Dr. George F Kunz, a gem expert of international reputation, estimates that the total production of the various diamond fields is a little less than one hundred and fourteen million carats.

Cutting a Highly Skilled Art

Naturally, the diamond in its rough state is useless except for technical purposes. It must be cut and polished with the highest degree of skill before it can take its rightful place as the queen of jewels. Early in the history of the lapidary art Amsterdam acquired a monopoly of the diamond-cutting industry, a monopoly she held until recently. The cutting of diamonds is a highly skilled art, difficult to learn, and mistakes made in cutting are extremely costly. Few skilled cutters were to be found outside of Amsterdam. With the World War, however, traffic in precious stones in Holland was seriously interrupted. Added to this was the rapid increase in the use of gems in the United States. What more natural than that the stones should be cut here? For a long period experiments were carried on in a small way, but larger wages offered in this country were a powerful inducement to highly skilled European workmen. Of late years, the industry has grown swiftly and to startling proportions.

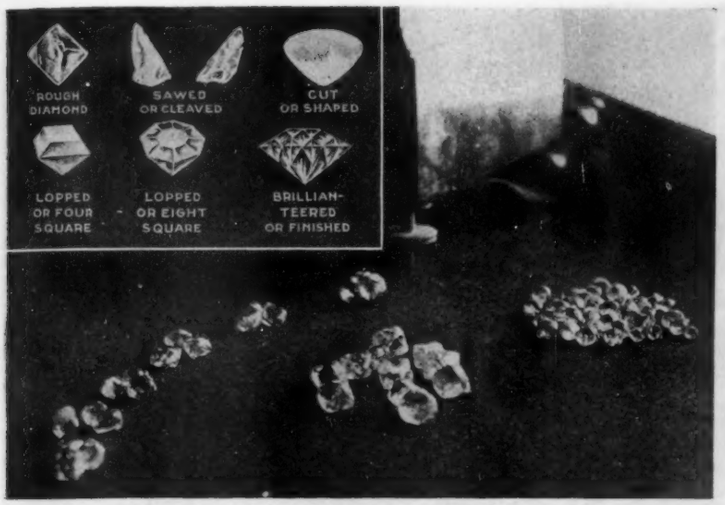
Each diamond has its own peculiarity; and each one must be dealt with individually to bring out its particular merits. The diamond is too precious to be wasted in experiment. The cutter must exercise wise judgment based on long experience; for an unskilled workman may ruin a valuable stone.

Before cutting, a diamond is given a close and critical examination to determine into which one of the recognized forms it can be cut to the best advantage. Upon the decision depends largely the profit to be made on the stone. Sometimes it is found that a large diamond of excellent quality contains several minute flaws which must be eliminated. Only an expert can determine how the stone should be divided to get the best results.

When he has made his decision, the examiner indicates by little scratches where the stone is to be cut. It then is passed to the "cleaver," who divides the stone by sharp blows on a steel blade. This process, too, requires wide knowledge of the forma-

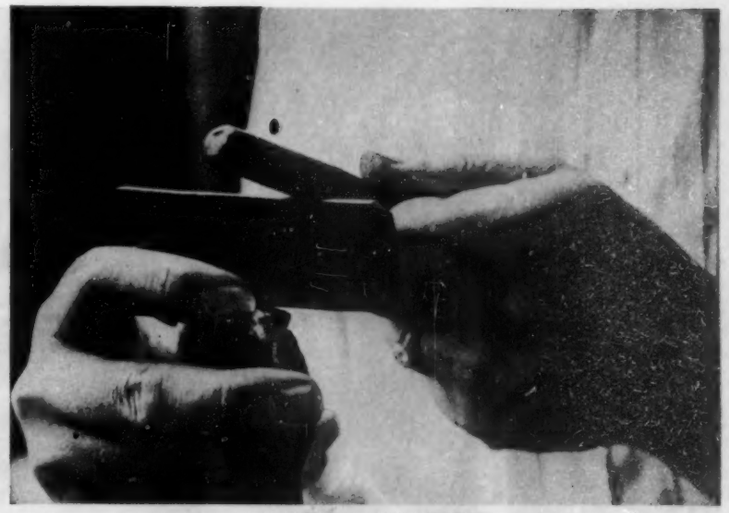
"LOPPING" OR PUTTING ON THE LARGE FACETS

This step in the process is performed by the revolving disk or lap, which is charged with diamond dust



ROUGH DIAMONDS AND THE PROCESS OF CUTTING

Twenty-five thousand dollars worth of uncut diamonds. The insert shows the successive steps in the process of cutting and polishing



CLEAVING THE DIAMOND

After the stone has been marked for cutting, it is divided along the cleavage planes with a steel knife. A sharp blow is all that is necessary to split it

tion of diamonds, for while they can be split easily on the proper planes of cleavage, they may be ruined if the tool is applied improperly.

Not only is the stone divided into the desired parts by the splitting process, but much of the superfluous material and the parts containing defects are removed by the same operation. There is still another shaping process, however, through which the stone must be put to bring it approximately to its final form. This is sawing, a process used widely in this country.

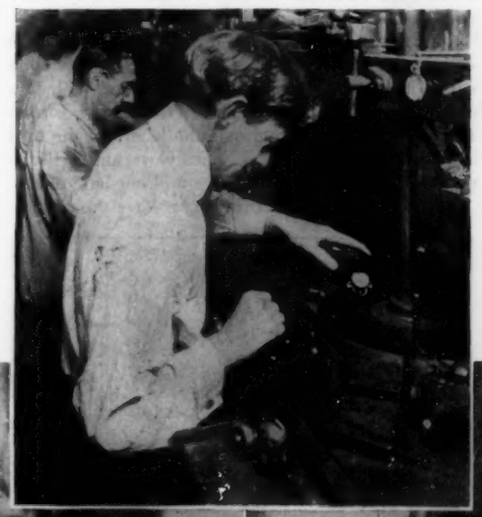
In sawing, the stone is first fixed in a holder by imbedding it in a small mass of lead in the end of the tool. Thus mounted, it can be held against the saw, which is a small disk of phosphor-bronze exceedingly thin and revolving at great speed. There are no teeth on the saw and it makes no impression unless its edge is kept charged with diamond dust mixed with oil. As the stone is slowly cut, every particle of waste material, both from the splitting and from the cutting is carefully saved for diamond dust for use in sawing and other operations; for the diamond is the only thing which has been found which will cut another diamond. The operation of sawing involves a high degree of technical knowledge and, in fact, is often carried on as a special trade within the general trade of diamond-cutting.

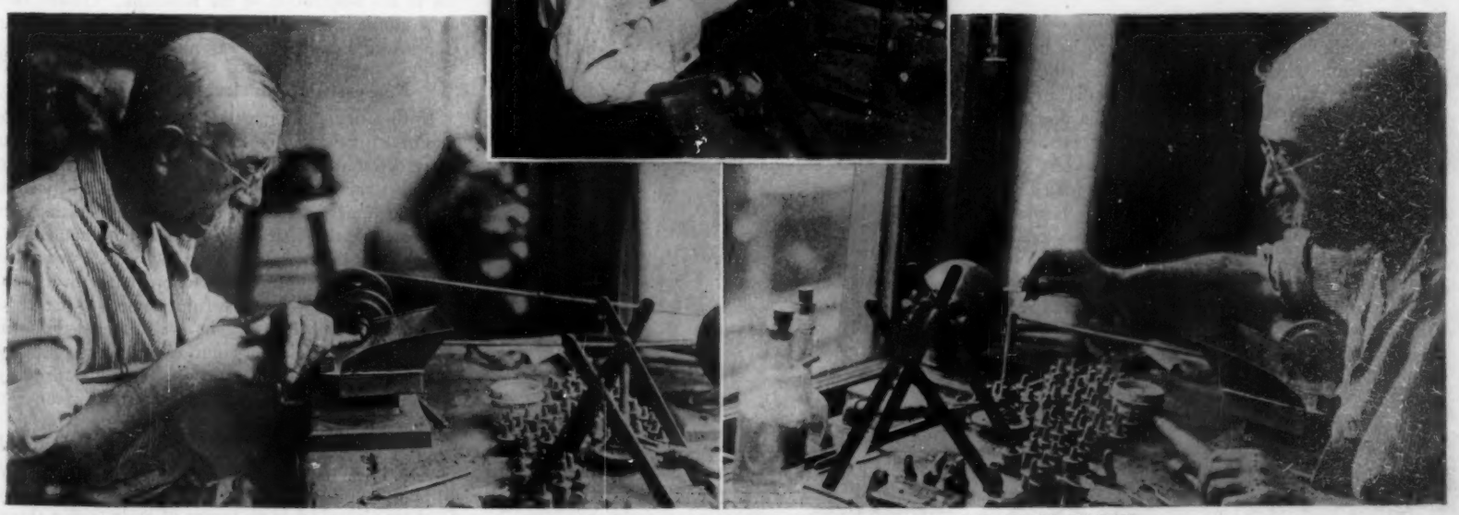
Sawing reduces the stone only roughly to its final size. To finish it and produce the many glistening facets, sometimes as many as fifty-seven in a well-cut brilliant, the stone must be cut or polished. For our drawing showing the sequence of operations to the stone we are indebted to Mr. A. T. Hunt, of J. R. Wood and Sons. Formerly, this was done by mounting two stones in separate holders and patiently rubbing them together, the two faces smeared with a mixture of oil and diamond powder. Now, however, the work is done on a horizontal iron wheel which revolves rapidly and upon which the stone to be cut is pressed by means of the holder. The cutting wheel is charged with diamond dust. Even with this mechanical aid the process is slow and requires great patience. The cutter relies entirely upon his eye and a false move would quickly end in disaster. The cutting of a single stone is the work of several days. The greater the number of facets, the greater is the danger of the stone being damaged in the workman's hands.

The sequence of operations is shown in our drawing. First, the rough diamond is sawed or cleft; then it is cut or shaped; then lopped to make it four square; then lopped again to make it eight square, and finally "brillianteered" or finished by putting on the small facets, when it is ready for its setting in gold or platinum.

In the process of cutting, about sixty percent of the weight of the rough stone is lost. The cost of cutting and the rarity of really fine gems in the rough account for the high price of the finished diamond. Weight often is a poor criterion of the value of a diamond, since the purity of the stone and the skill exercised in its cutting are what count most.

Diamond-cutting is an industry which not only requires great skill but it is of ancient and honorable lineage. Although it now centers in New York City, Amsterdam may still take comfort in the thought that a considerable number of the diamond-cutters in the United States are native Dutchmen.





DETAILS OF CUTTING—FROM SHAPING THE STONE TO PUTTING ON THE SMALL FACETS

LEFT: *This is a diamond cutting another diamond. One is in a lathe, the other in a holder.* RIGHT: *Diamonds are cemented in a "dap" or holder preparatory to cutting.* UPPER INSERT: *Brillianteering or putting on the small facets which are produced on the revolving lap*

Irving Galloway

The Carolina Wren

This Happy, Optimistic Mite of a Bird Is a Musician, Architect and Artisan

By S. F. Aaron

THE early naturalists in America, as in no other countries, were woefully twisted in the matter of names, thus giving the nature observers of later generations some cause for complaint. Not only were absurd appellations used in imitation of Old World names, as, for example, the names robin, partridge, pheasant, quail, panther, adder, and so on, but also such erring terms as make us think of restricted habitats. Thus we have the term thrush applied to warblers and warbler given to many birds that do not warble and for widely distributed species, such titles as Maryland yellow-throat, Kentucky, Tennessee, Nashville and Connecticut warblers, Louisiana heron, English snipe, English and French mocking-birds and Carolina wren.

Not Native to Carolina

The Carolinas have no more right to be honored with the name of this little songster than have any other states south of Middle Pennsylvania and New Jersey, Southern Ohio, Indiana, Illinois and Iowa, the range of the species not extending far west of the Mississippi River, but all over the eastern, southern and mid-southern United States. Added to this misapplied appellation is another specific misnomer. The systematist Gmelin, having received specimens solely from Louisiana, called the species *ludovicianus*. Although Wilson, ignorant of Gmelin's work and falling into the more common error, had named the bird *caroliniana*, Audubon, Nuttall, Bonaparte and subsequent students up to the present day must follow the prior naming.

Then, as though not content with the extent of these absurdities, Viellot wished to put the unoffending little creature into another genus, calling it mistakenly a leaper of reeds, *Thryothorus*. This name was rejected for a time, although it is now admitted, so that, if we wish to be accurately specific in a universal understanding, we refer to the bird as *Thryothorus ludovicianus*, the reed leaper of Louisiana. Sometimes one must incline to the beloved Burrough's idea that scientific names are uselessly cumbersone and often misleading.

It is not less amusing to note the variations in the descriptions of the species. Wilson and Audubon called it the Great Carolina Wren and gave its length as five and one-quarter inches. Coues and Jordan leave off the "great" and note the length of the bird as six inches. The United States Government Bulletins and Ridgway give it as five and one-half inches.

It is likely that most bird lovers have their favorites among these feathered friends that are at least better understood. Thus, I have heard some select the intrepid little hawks; some the wood thrush, solely for its musical ability. Others choose the kingbird or the shrike. I know one intellectual student of birds that most admires the crow.

All drawings by the author

THE SONG OF THE WREN

This drawing shows the singing attitude of the Carolina Wren. These birds sing also when they are fighting

The father of American ornithology probably favored the bluebird more than any other, as did Burroughs; Maurice Thompson chose the mocking-bird. From their complete writings one might infer that Job would select some of the sea birds, that Chapman most favors the veery, that Stone could grow moderately enthusiastic over the purple martin, that Ridgway's favorite is the western meadowlark, that Spencer Baird loved the thrasher and that David Starr Jordan very possibly agrees with the poet Bryant in his admiration of the bobolink. Others, such as Audubon, Nuttall, Brewer, Maynard, Samuels, Coues and Bendire express no preferences.

Possesses Remarkable Vocal Powers

If this deponent may have a feathered favorite, one of truly heroic mold and one that is worthy of the greatest admiration for its abilities as a musician, architect, artisan, its happy, optimistic disposition and its domestic virtues, then none other than our little friend, the Carolina wren must be named.

I confess that the barn swallow, with its excellent nest building—combing masonry, basket-work and mattress making—its cheerful twitter, its poetry of motion on the wing and its well managed family affairs reaches a close second, easily overtopping all but the voluble, intrepid, ever-happy, sprightly, amusing, more than active, thumb-sized gleaner in hidden places, the Carolina wren.

First perhaps is the song. And who, loving all that is beautiful, can fail chiefly to note it! This little bunch of flesh and feathers, which, with the feathers picked off is no larger of body than a shrew, is most remarkable for its vocal powers. A certain sweetness of tone might be expected, from the fact

that it is a wren. The loudness of its notes may also be explained in part as a matter of heredity. But even that cannot anticipate the wonderful volume of sound that comes from the throat of this mite. It is probably one of the loudest bird songs of any kind to be heard anywhere and it comes from one of the smallest of the warm-blooded, back-boned creatures in existence. How, without splitting its larynx, shattering its palatine bones and jarring its entire system to the point of sudden dissolution, it can emit such high-pitched and penetrating vocal efforts is beyond understanding. How such tiny lungs can get sufficient force into sounds that sometimes can be heard for over half a mile and are always believed by the listener to come from a creature ten times the size is hardly to be comprehended.

If one may find even a poor excuse for putting bird songs into words, the Carolina wren's commonest utterance may be written: *weet-so, weet-so, weet-so, weet-so,* the eight or ten syllables given rapidly and repeated about ten times a minute. The second syllable of each note is higher pitched. There is also heard, and perhaps as often, a decidedly different pronunciation which may best be likened to *tootle-tootle-tootle-tootle,* the last syllable lower. Sometimes the notes are pitched so that the highest one is about middle C on the piano; at times, especially during the breeding season and when the birds are fighting, there is greater rapidity and more than half an octave higher is reached without, of course, any particular key being chosen.

Sings All Through the Year

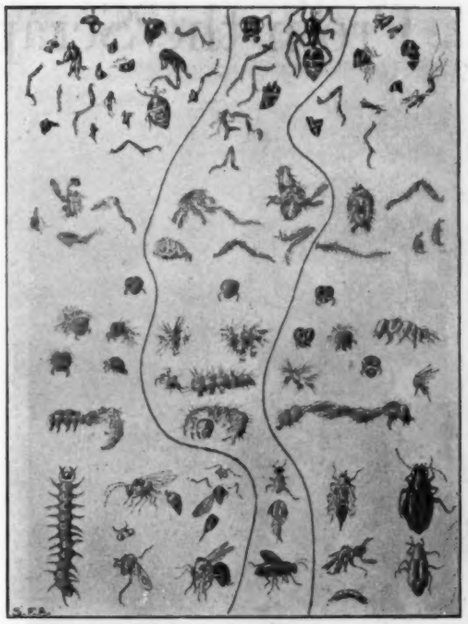
Fully as remarkable is the fact that this small bundle of energy sings all the year round—on the hottest days, far into the fall, often on the coldest, windiest days of winter and more often when a bright sun slants upon a world of wind-drifted snow. This habit, shared only by one other of our avian fauna—the mocking-bird—is positively demonstrated in the wren's southern habitat, but also, although less frequently, in its more northern haunts.

Penetrate thicketed patches, covered deep by the Frost King's mantle, and the most cheery call you will hear, nearly the most musical in any season, will be the far-flung, three-syllable song of the Carolina wren. It rings out through the frosty air, a veritable beacon of sound, at delightful odds with the wintry surroundings and the landscape and like unto nothing that we may expect, each time a surprise even to him who has heard it before.

Among bird lovers, Audubon showed the greatest appreciation of the Carolina wren's song. With his not unusual exaggeration he ascribed to it mimicking sounds and named the bird also the "mocking wren," but there is not the least reason to suppose that the notes are meant to imitate other sounds of any bird; not even the bird's musical trill of alarm nor of self-communion is like that of any other bird or animal.

NEST OF THE CAROLINA WREN

The exterior is entirely of twigs and small roots. It is placed in a large brush heap in the woods



CONTENTS OF STOMACHS OF WRENS

LEFT: *Bird shot in April.* CENTER: *Bird shot in June.* RIGHT: *Bird shot in October. Ants, spiders, caterpillars and a miscellaneous assortment make up the bulk of the food. Much is difficult to identify. Comparatively indigestible parts, such as the heads of caterpillars, remain whole longest*

The Carolina wren earns also the unique distinction of being, among passerine birds, the only non-migratory species inhabiting temperate eastern North America. I have given the closest observation to a number of these birds of both sexes and to definite pairs nesting in certain localities and not once have I failed to note that individual wrens, told by certain definite characteristics, remained in or near the neighborhood where they nested, perhaps traveling half a mile or a little more along lines of hedges and thickets to insure well-filled stomachs.

At this time I know of three pairs of Carolina wrens each of which have inhabited sections of a few acres in extent, one an old mill site, the other pairs in patches of thicketed woods and for five years they have strictly adhered to their chosen locality. I am only at a loss to know what becomes of the young of two broods each, aggregating thirty, successfully reared each season. No doubt there is a large mortality among them, especially from hawks and shrikes; that they do journey away is certain, but how far?

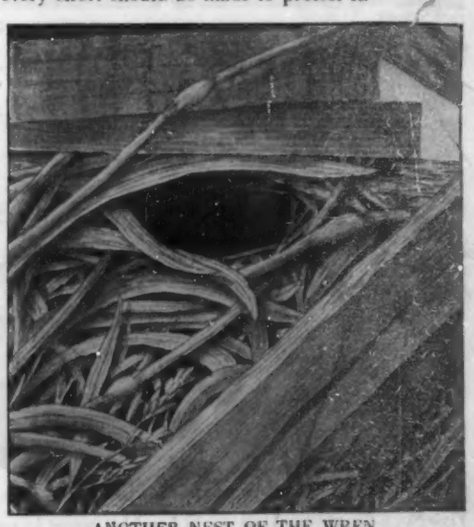
The nests of the Carolina wren differ little from those of other species of the same family, except that the former are not attached to reeds like those of the marsh wren nor are they constructed within such restricted spaces as those chosen by the house wren. Placed in rocky chinks and crannies, in dense masses of brush and thickets of broken-down briars, in holes made by the rotting limbs of fallen trees, always out of the reach of such larger enemies as the squirrels, the fair-sized snakes and even the short-tailed shrew, the birds need fear only such smaller reptiles as the garter and ribbon snakes, more rarely the long-tailed shrew, which creatures they combat with such fury as often to defeat them.

I have examined more than forty nests of the Carolina wren, mostly in the mid-southern states, some in Pennsylvania, Delaware and Maryland and have always found them as above described. A bulletin of the United States Agricultural Department asserts that they are sometimes placed in vines, but I have never seen them in such situations. There is a great variation in the material chosen, and this variation is not geographic. Two nests in Tennessee, placed as close together as the rivalry between the males would allow, were built in the manner most commonly employed: a rounded mass with the entrance hole near the top of one side. And as usual the insides were lined with feathers and a downy stuff plucked from some unidentified vegetation. But the outside of one nest was made entirely of coarse sticks and twigs, some short pieces being almost as thick as a lead pencil, while the exterior of the other nest was solely of fall grass, sometimes called horse grass—possibly because horses will not eat it.

Not even the nest of the ovenbird, the meadowlark nor of Mrs. Bobwhite can equal the sheltering compactness and mass strength of the Carolina wren's nest. The female does it all, but should her lord and master, who is often woefully henpecked, dislike the situation for any reason—and such is frequently the case—he will build a nest of his own in which, at times, he may roost. This nest is generally quite superior to that of the female, being more bulky, better put together and softer inside; but invariably, I think, she turns him down, occupies her own mansion and the little ones are reared therein, being fed also by the paternal hustler. The wren-like agility of both parents, surpassing perhaps almost any other bird even of its nearest kin, insures an abundance of nourishment to the young, who fly in about two weeks after hatching.

Its Food Mainly Noxious Insects

The contents of the stomachs of birds have been carefully studied in Washington, the averages being quoted as very representative. In my own observation of those birds of the species, shot for museum specimens, the general menu holds much alike in all, with some differences in percentages of species. The busy little gleaners get those insects that frequent the places where the wrens seek shelter; thus spiders, ants, barkflies, ground beetles, black crickets, cave crickets, the caterpillars and chrysalides of moths and those arthropods that crawl into lowly places to hibernate, naturally compose the bulk of the bird's food. Some of these creatures, such as spiders and certain rapacious insects are beneficial, but it is safe to say that the majority are noxious species. Thus the economic value of the Carolina wren is assured; and, since this is the case, every effort should be made to protect it.



ANOTHER NEST OF THE WREN

This nest was found in a scrap lumber pile. In contrast to the other, the exterior is made of grass

From the Scrap-book of Science—Came

Kadel & Herbert

THE MECHANICAL TRACK INSPECTOR

Oscillations and jolts due to imperfect railroad tracks, register themselves automatically on a roll of paper moving through this device. Separate records are taken of up and down jolts, sidewise jolts and lengthwise jolts. After a run it is possible to locate any given defect which has left its record

Pacific & Atlantic

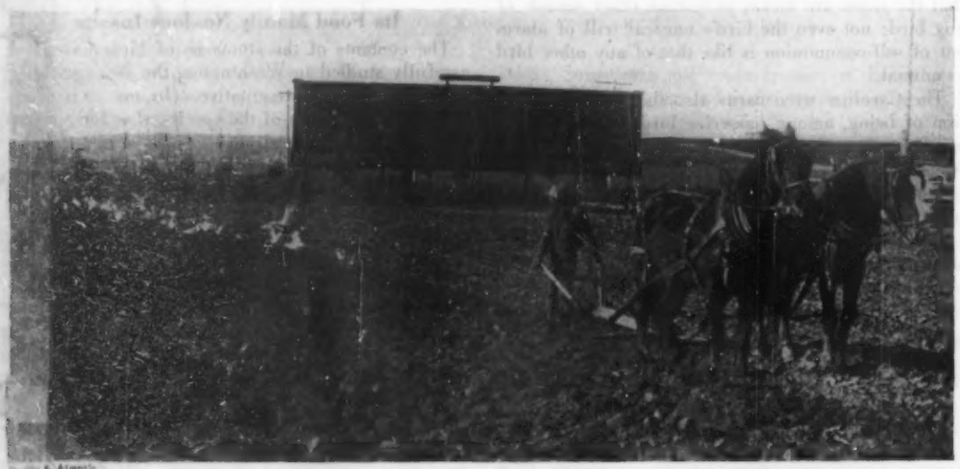
HOW BLOW THE WINDS ALOFT?

A hydrogen balloon is being released while an observer stands nearby with a theodolite, ready to follow its course as it rises and floats down-wind. Some of these balloons have gone as high as 90,000 feet. By following them with these instruments it is possible to determine the velocity of the wind at various levels. This information is of great value to aviators

Kadel & Herbert

THE BUSHMAN'S CANDLE

If you light the stems of this plant they will burn like tallow candles. The plant grows in the deserts of South Africa, a region formerly inhabited by large numbers of a primitive negroid race known as Bushmen. Hence the plant's name



Pacific & Atlantic

PROVING AN OLD MAXIM

The old maxim that the early bird catches the worm is surely true in this case. The sea gulls meet the plowmen every morning at sunrise and the most active of the group quickly get their fill and depart. This picture shows a plowman and birds near La Jolla, California

Ewing Galloway

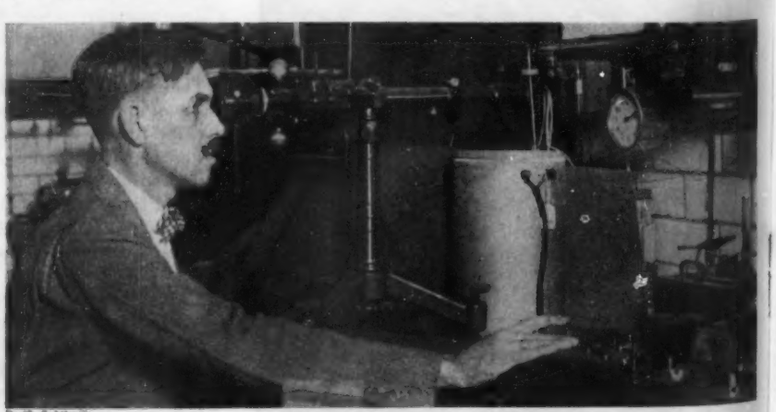
HOW NEW YORK GETS ITS DRIN

The interior of the concrete-lined tunnel which carries water from the City—the world's largest and most expensive municipal water system. Steel siphon pipes, buried well below the surface, ta

Wide World

WHERE IS IT?

Trying to locate airplanes that can be heard but cannot be seen. The Army has been developing this sound-ranging apparatus as an aid to the human ear. With our ears we judge direction of sounds by combining the impressions received in the respective ears. Above is a battery of super-ears, which may be turned in all directions



Pacific & Atlantic

EXPANSION OF PRECIOUS STONES DETERMINED

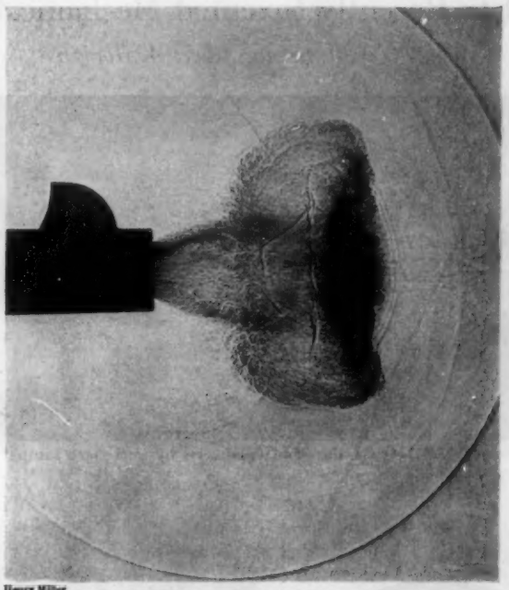
G. E. Merritt, expert at the U. S. Bureau of Standards, looking into a blazing furnace where diamonds and precious stones are heated to certain temperatures to note their expansion. The Bureau of Standards has been cooperating with the makers of dishes, telling them the best way in which to make them so that hot foods will not expand them unevenly, thus causing them to break

-Camera Shots of Scientific Happenings

Kadel & Herbert

A LOAF, OR A STONE?

This South African plant so closely resembles a stone that it is hard to distinguish from a stone. It is composed largely of water and provides a welcome thirst quencher for both human beings and animals. In the foreground is a real stone



Henry Miller

"SEEING" THE BANG OF A GUN

This is the muzzle of a .45-caliber revolver just before the bullet has emerged. The round, black curve that shows is the primary sound wave, photographed by the United States Bureau of Standards. Sound waves are local condensations of the air. This fact enables them to be photographed, since light is differently "bent" as it passes through these areas of greater or less density

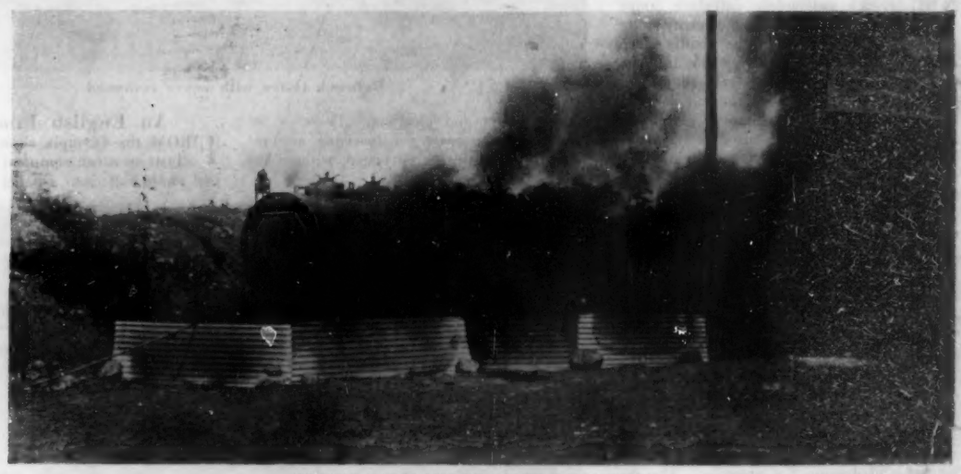
Keystone View

HOW OLD IS "DIFFUSED LIGHTING?"

We have heard much about the recently-discovered value of diffused lighting. Here, however, is a cobbler's lamp of the Middle Ages. By placing a candle between four globes of water the light was diffused in a crude way. This was given to Dr. John Finley, when he last visited France

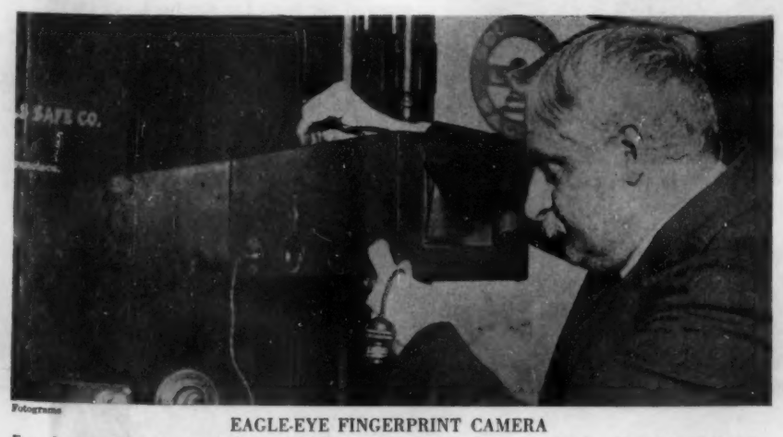
RK GETS ITS DRINKING WATER

arries water from the Ashokan Reservoir in the Catskills to New York nicipal water system. The three channels are for siphon connections. below the surface, take the water across low valleys



TRUCK TANK UNDERGOING FIRE TEST

Severe tests had to be passed by this gasoline truck tank before New York City would permit its use in the streets. These tanks were barred until recently, owing to such possibilities as that of gasoline in large quantity running from them into subways and being ignited by sparks



Fotogramo

EAGLE-EYE FINGERPRINT CAMERA

For photographing fingerprints, George Blum, official photographer of the San Francisco Police, has invented a special camera, that does the work perfectly. The camera is equipped with six small electric lights, placed in front of the lens, no other light being necessary to make the photograph. It also has attachments for the use of ray filters, when it is necessary to register color

International Newsreel

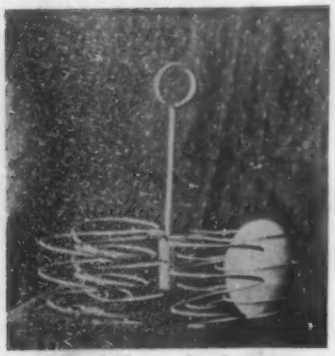
EGGS OF EXTINCT REPTILES

The third Asiatic expedition has returned from Mongolia with new finds of animal life. A closeup of the contents of the nest of the 100,000,000-year-old dinosaur eggs. These eggs are about eight inches long and the fact that they were dinosaur eggs was determined by finding the embryos of tiny dinosaurs in some of them

Novel Devices for the Shop and the Home

A Department Devoted to Recently Invented Mechanical and Household Appliances

Conducted by Albert A. Hopkins



Egg boiler made of wire

Egg-Cooking Device

EVERY housewife will appreciate this latest novelty for the kitchen. It is an egg cooker, server and detector. From one to six eggs may be boiled in this device at one time. When they are taken out of the water, they may be served on the table in this cooker. Spoiled eggs may be detected when boiling, because they will float out of the separate holders.

Anti-Glare Auto Lamps

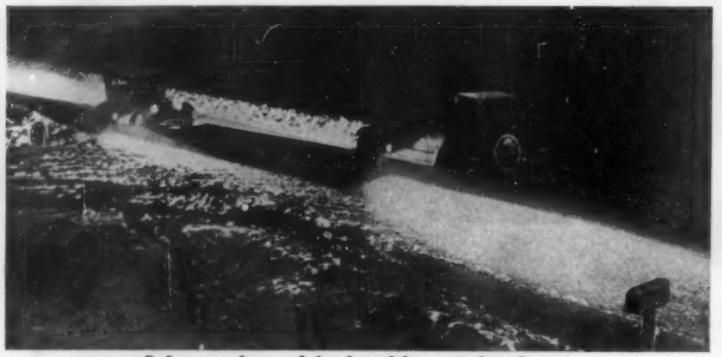
THESE new automobile anti-glare lamps will undoubtedly eliminate many auto wrecks which result from the deadly glare of an oncoming car. They come in sets, two to a car. One lamp is placed on the fender on the left side of the car focused to the rear. The other lamp is placed on the right fender and is focused to the front of the car. The lamp on the right gives full vision of the road ahead and the one on the left gives the oncoming car behind a light on the road.

Safe Lowering of Tools

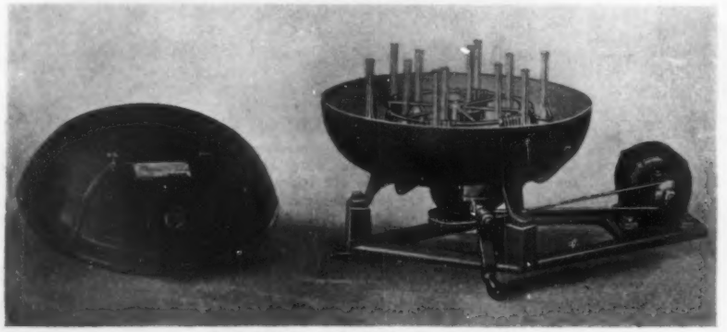
IN almost any industry, and particularly in the electrical trades, it is often necessary to raise or lower a tool to a workman. Throwing tools from an elevation has resulted in thousands of serious accidents. The Detroit Edison Company has solved the problem by attaching rings to the various tools so that a line may be secured to the ring. The tools can thus be lowered or raised with safety to the workman and without endangering the passerby. The device is very simple and is strongly recommended. Danger from falling tools will be absolutely eliminated by this very simple device.

Motor-Driven Babcock Tester

THE Babcock cream tester has now been provided with a motor which adds to its speed and efficiency. It is also arranged so that it can be driven by hand power. The bowl is made in two separate sections, the upper half of which may be removed easily for inspection and cleaning. There is an opening in the cover for inserting and removing the bottles being tested, without removing the cover.



Safety on the road furthered by anti-glare lamps



Babcock tester with cover removed

An English Innovation

FROM the Olympia show in London we illustrate a car equipped with a compact tool chest built into a panel of the door.

A tool chest built into the door of an English car

Line rings for tools

A Shiftable Top for Automobiles

THE top is of rigid construction and is shiftable by hand to and from a position resting on the rear deck. Counterbalancing springs carry the dead weight of the top so that no appreciable effort is necessary to effect the shifting operation. This type of top structure allows the car to be changed in a moment from an uncovered roadster to a weather-tight coupe. Door windows rack up and the quarter windows quickly clamp into place. These latter windows are housed in a compartment back of the seat when not in use. A movable panel in the top allows use of the deck seat when the top is lowered. The top consists of an ash frame, padded and covered with water-proof fabric. It is securely clamped in either position so that no shake or rattle is possible. With the roadster increasing rapidly in popularity as the sport type of car, this top construction is interesting because it offers an improvement needed in the roadster, namely, a top which is easily lowered or raised and one which will not lose its appearance by repeated lowering. Furthermore, the fact that the car is quickly made into a snug coupe if the weather becomes inclement is decidedly advantageous.

An English "Safety Line"

A REMARKABLE form of white line is now under test in London. In the center of the North Circular Road, say *The Engineer*, an illuminated line over 30 feet long has been laid. The "line" is contained in a wrought iron trough sunk to the road level. In the trough are electric lamps, and the trough is closed with alternate sections of reinforced white marble and prism glass. Thus the line is visible both by day and night. The lighting up and extinguishing switch is controlled by a clock.

This top is of rigid construction and is shiftable by hand from a position resting on the rear deck to the positions shown in the illustrations

Safety for baby's bottle

A Bumper for the Baby's Bottle

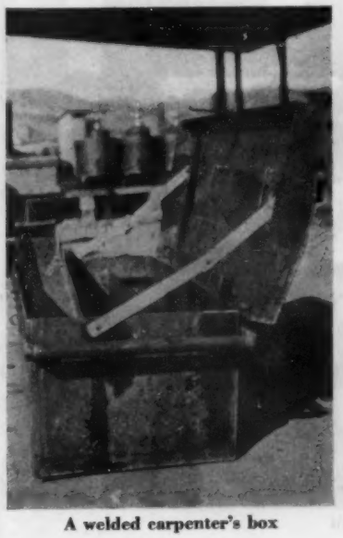
BOTTLES are apt to fall from baby hands and break. This rubber frame for them affords protection against such accidents, because it provides an anti-skid grip for little hands. A bottle thus protected will not break, nor will it roll out of reach. The frame need not be removed when the bottle is washed.

An Improved One-Man Saw

AN improved hand tool which is being used by a number of telephone and public service companies, though designed for the farm, is shown in the illustrations. Some of its advantages will be readily seen. It will do the work of a two-man saw, without making it necessary for the operator to stoop. It folds compactly for transportation, has a spring tension that feeds the saw according to the strength of the operator, in any position desired; and it is moderate in price. The principle on which the saw works is based on the operation of a pressure bar. A steel coil spring connects the pressure bar to the handle and operates to keep the saw pressed against the log at all times, causing the blade to cut as efficiently on the return stroke as on the forward one, and without increasing the labor of the operator. The spring is adjustable so that the pressure can be regulated to suit the width of the log to be sawed. The tool consists of a strongly built frame of the best steel tubing with all joints brazed and a saw blade of finely tempered rolled 13-gage saw steel. The saw teeth and rakers are of special design, determined by years of actual experience by R. W. Graves, a Canadian woodsman, the inventor of the saw.

A Box Without Bolts or Rivets

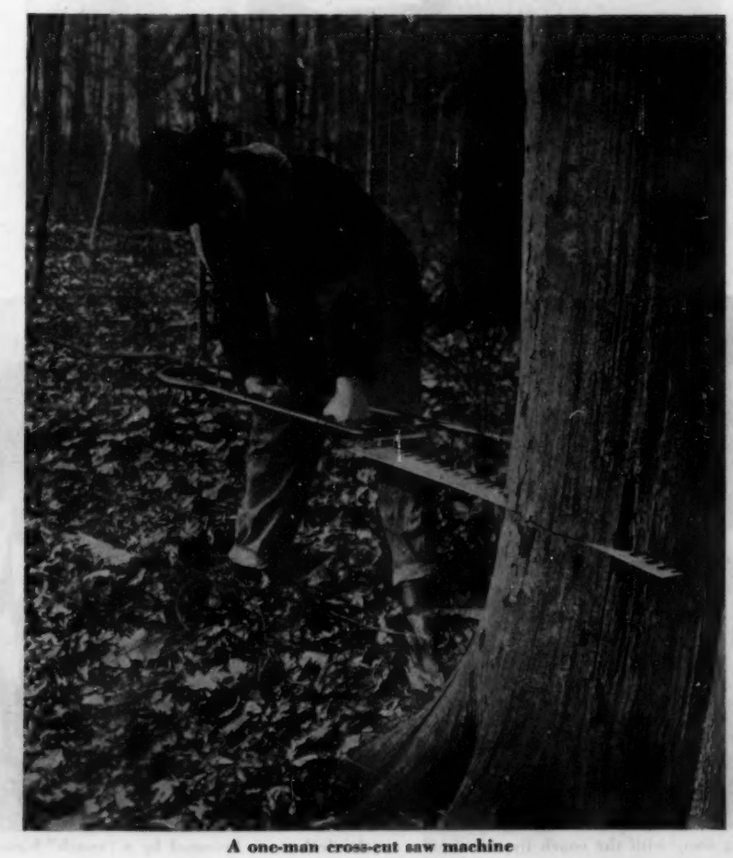
THE carpenter's box which we illustrate is welded throughout, so that there is an entire absence of rivets or bolts.



A welded carpenter's box

Cutting a twenty-six-inch cherry log with a one-man saw. Notice the spring tension that feeds the saw

A booster for the grease gun consists of a small metal unit producing extra pressure, particularly in case of clogged or tight bearings



A one-man cross-cut saw machine

A cap that can be pried off and resealed

An Easily Removed Bottle Cap

TO open this new bottle it will be unnecessary to search for a bottle opener or for a handy nail on which to rip off the cap. The rim of the bottle is constructed in such a manner that a ledge guides the blade of the opening medium upward so that it comes in contact with the crown cap without striking the glass locking rim. A coin, key, knife, or any flat piece of metal applied under the edge of the cap and twisted will remove the cap without any mutilation; and the reseal value of the bottle is preserved, for the cap may be put on again and it will be tight. In the use of this new device it is claimed there is not the danger of chipped bottles which is common to other types.

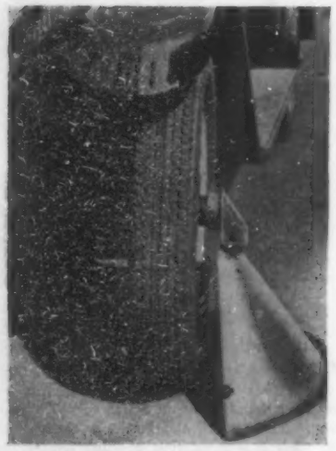
Greasing the Auto

A SMALL metal unit which can be readily attached to any grease-gun by means of a screw-thread is of great assistance in greasing the auto. The extra pressure on the grease is produced by a piston operated by a very fine screw thread. A handle on the outside permits of the booster being operated by a few turns of the fingers—raising the pressure from an average of five hundred to five thousand pounds. This is a great advantage in cases of clogged or tight bearings which resist the pressure of the ordinary grease-gun.

A Handy Rod for the Angler

WITH a locking device the guides of the fishing rod shown on this page are kept in perfect alignment. The caps, when screwed down, lock the joints in position; and they cannot creep out of position, even under the heaviest use. The ferrules are not depended upon to hold the sections together. Our illustration shows the butt section about half way out of the handle. It also shows the notch in the handle part and the section which, when held together, prevents twisting. To insure against rusting from the inside, each section is covered first with a rust-proof priming coat, which is baked on, and then with two coats of tough, glossy, baked enamel.

Lock-jointed steel rod



Loading anchor for automobiles

Metal Loading Anchor for Automobiles

THIS new anchor for automobiles cuts down the labor and assures safety. The construction is clearly shown by the engravings. There is no danger of the anchor injuring the tires, because the machine is suspended from the hubs. The metal anchor is very durable and is for this reason superior to one made of wood, which is only good for one trip.

"Dryice"—a New Refrigerant

UNDER this name a very useful preparation is now being marketed. The name is a trade-mark and stands for solidified carbon dioxide gas. It turns to a clear dry gas without giving out a liquid. Physically, it resembles a cake of well-packed fine snow, harder than water-ice and nearly twice as heavy. It is shipped and used in a paper wrapper. This product makes it possible to buy ice cream on the way home from the office and consume it six hours later. A disk of dry ice wrapped in an insulating compound is placed in the container first, then the ice cream. Our engraving shows a store window in Boston with the product displayed. There is no danger of drip, because when the ice wastes away it is in the form of a gas. "Dryice" is most efficient for refrigerating show windows, a job which has always been difficult with ice-encrusted pipes.

Taking Shot from the Soil

WITH a new invention, a specially constructed sluicing machine, Charles Loveridge and A. E. Cox are attempting to clear shot from the ground on which the Portland Gun Club, Oregon, has been shooting for years. The field has been plowed several times, and the ground to a depth of ten inches is filled with shot. From the dirt that clung to the roots of an old corn shock, a tablespoon of shot was panned; and four hours' work with the sluicing apparatus over a surface measuring about six by twenty feet yielded six hundred pounds. It is estimated that there are about one hundred tons of shot to recover. Probably other gun clubs could use the machine to advantage.

"Dryice" is really solidified carbon dioxide

Taking shot from the soil

Side view of the anchor

A Mechanical Pacer

DESIGNED to revolutionize the coaching and training of track athletes, a machine called a "pacer" has recently been invented by Coach Thomas E. Jones, of the University of Wisconsin, Madison. Officials claim that the device will be invaluable in teaching runners how to judge their pace. The invention, the result of four years of experiment, is merely a wooden box with a bell in it, and so constructed and timed that the bell rings at regular intervals. A runner attempting to do the quarter mile in sixty seconds will set the machine to ring every twenty seconds. Every time he completes one of the three laps on the indoor track at Wisconsin he can check up on whether he is running ahead or behind schedule. The same scheme is of use in judging pacing for distance runs.

For years coaches have held a watch on their men and instructed them after each lap of the track whether to maintain, decrease or to increase their stride, but Coach Jones has invented this ingenious instrument which can be set to ring at any desired interval. Experienced runners can frequently estimate within one or two seconds the time it has taken them to run a mile, gaged by their stride and the pace set. Nurmi, the great Finnish runner, carries a stop watch. The same machine will be used by Coach Vail of the Wisconsin crew for rhythm in training the "Varsity 8." The machine will be used also on the outdoor track. Gongs will be placed at intervals of one hundred and ten yards on this quarter mile track and wires will lead to the machine so that the dial can be set for any speed desired. The device is portable.

Doing away with the coach by means of a mechanical pacer invented by a "coach" himself

The Scientific American Digest

Newest Developments in Science, Industry and Engineering

Conducted by Albert G. Ingalls

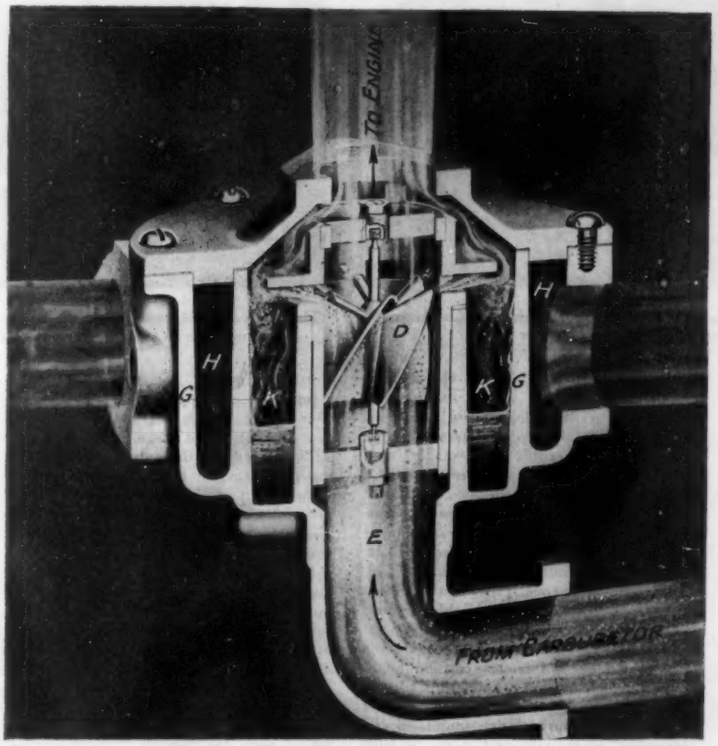
Doubling the Automobile Mileage Per Gallon

As everybody knows, the object of the carburetor is to furnish "gas" or gasoline to the motor. Gasoline being a liquid, it gets to the motor partly as a vapor (in gaseous form) and partly as a fine mist, due to the action of the jet. This latter is undesirable, as it makes a fuel of variable composition and richer than is economical. The best results are obtained by the use of a wholly gasified fuel mixed with air in the proper proportion. This is brought about, according to Augustus H. Gill, Ph.D., Professor of Technical-Chemical Analysis, Massachusetts Institute of Technology, by the throwing-out of the gasoline mist or droplets from the carburetor mixture, by the highly ingenious and compact attachment known as the Bursley-Trask Fuel Adjuster.

Briefly described, this consists of a bowl heated by a portion of the exhaust gases, containing a rotor with vanes curved at the top, which by centrifugal action, separate out the mist, dust, and so on, from the gasoline-charged air stream.

The apparatus is attached between the carburetor and the manifold. In the sectional view, G shows the bowl of aluminum or aluminum alloy, heated by a portion HH of the exhaust gases; a portion only being used, so as not to heat the gasoline vapor too hot. The amount of heating, according to the season may be regulated by a damper. K shows the pocket into which the atomized gasoline or gasoline mist is thrown: road dust is also removed from the air stream and collected here. D shows the rotor in the air-gasoline stream. This is made up of six spiral blades, curved over at the top, which are fastened to a hardened steel shaft, which runs in a jewelled bearing of sapphire, with end stoned of the same. This is comparable with the balance wheel "staff" and bearings of a watch, and has a similar length of life, sapphire being next in hardness to the diamond.

The rotor D is set in motion by the air-gasoline stream E from the carburetor. This stream moves with astonishing velocity, attaining a speed of a mile a minute. As is evident from the figure, it throws out by centrifugal force, all heavy particles passing through it. It will even separate oil from gasoline! These heavy particles (the gasoline mist and road dust) fall into the pocket K. Here all the gasoline fit to burn is changed to vapor by the heat from the hot gases surrounding HH, and passes up into the manifold. It will thus be seen that the device takes the heavy "ends" or kerosene-like stuff out of the gasoline. The instrument practically effects a redistillation of the gasoline on the car itself, and furnishes the motor with a purer and much more uniform fuel, and one that is readily and completely combustible. These "ends" collect in the pocket KK, where they are washed out from time to time together with the road dust.



Details of a centrifugal carburetor which throws out all particles of foreign matter in the gasoline, preventing them from doing injury to the engine

The heavy "ends" when introduced into the motor, by the ordinary carburetor, cause the following troubles, which are too well known to every motorist. 1. Formation of carbon or soot due to imperfect combustion. 2. Formation of tarry matters which cement together the actual carbon above formed, with the road dust, to make the familiar deposit of "carbon." This clogs the valves, prevents their seating, and grinds out the pistons, rings and cylinders. 3. The heavy ends wash the oil off the pistons, rings and cylinders, and prevent adequate lubrication. They find their way into the crankcase and thin out the oil. The road dust also mixes with the oil in the crankcase and wears out the bearings.

Discussing these different troubles, we find: 1. The soot formation is due to too rich a mixture, there being insufficient air present to burn all the carbon. 2. Tarry matters are due partly to imperfect combustion as described in 1, and partly to the heavy oils composing the heavy ends. 3. The heavy ends. These are at present inevitable in the manufacture of gasoline. They are universally recognized as harmful, but cannot as yet be cheaply eliminated.

The instrument was put on a Ford runabout and operated by different drivers. The method of operation was as follows: The gasoline in the tank was always measured by allowing the car to stand upon a certain level concrete slab until the gasoline was still. The depth in the tank was measured with the usual measuring stick, which had been carefully calibrated, giving easily tenths of a gallon. The cyclometer was new, and gave readings to tenths of a mile. The tire of the cyclometer wheel was kept properly inflated. The car was operated in three different directions—north, south and west, under as nearly identical weather conditions as possible, over the same roads and at practically the same average speeds.

Average of seven runs without the adjuster—19.2 miles per gallon. Total mileage 373.

Average of five runs with the adjuster —34.2 miles per gallon. Total mileage 236.

Showing a gain of 15 miles per gallon, or 78.5 percent.

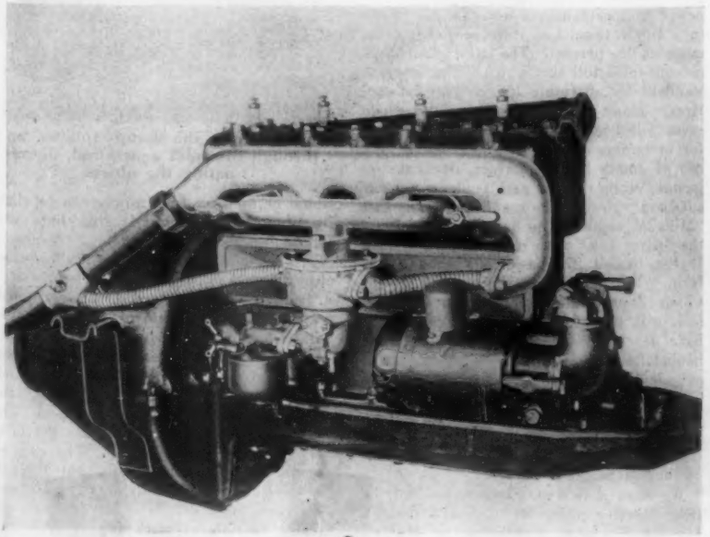
I have no doubt that in warmer weather, and under more favorable conditions, a gain of 100 percent would be found, or the mileage per gallon would be doubled, which has actually been attained in one run. This will hold true especially with the new and more perfectly made instruments.

* * *

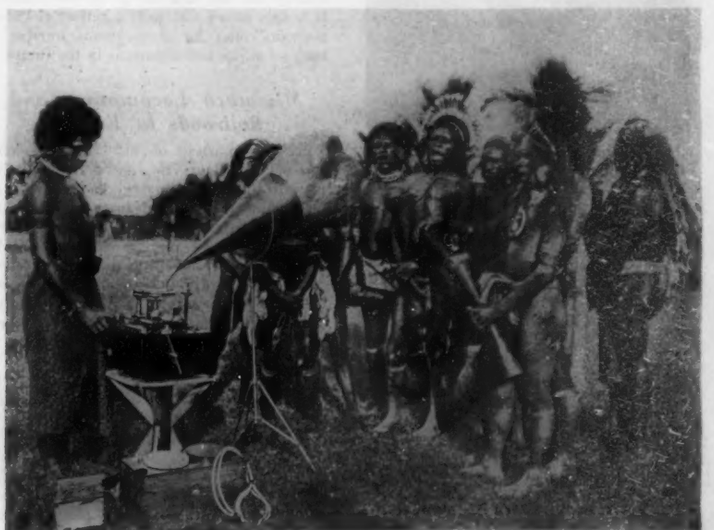
A Museum of Sounds

RESEARCH workers in anthropology, the science of human culture, use phonographs for recording permanent records of the speech and music of primitive peoples whom the onward march of civilization has marked down to disappear within a few generations; but only since the end of the last century have comprehensive collections of records been systematically made for scientific purposes.

One of the first scientific institutions to take up such work was the Academy of Sciences in Vienna, which established some twenty-five years ago its now well-known

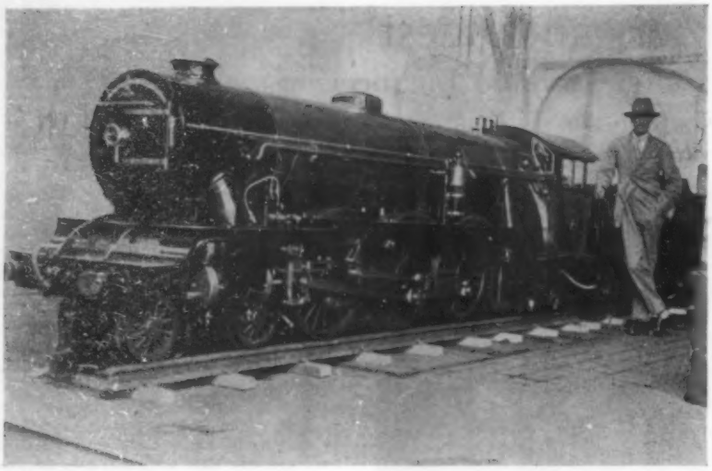


The centrifugal carburetor applied to an engine. The rotor shown in the drawing at top of page is heated by a by-pass from the exhaust



Photograph courtesy of Prof. Rudolph Pöch

Making permanent records of native songs that will soon be forgotten when the inevitable encroachment of civilization absorbs a savage race



The "Green Goddess," a miniature locomotive in regular freight-and-passenger service in England. It draws ten cars at 35 miles per hour

© Miss Mary O. Pair

The "River Esk," a miniature locomotive, hauling rock from a quarry. These engines are not toys, but must earn their keep by work, year after year

Phonogramm-Archiv, or "Phonogram Archives."

Metal matrices made by a galvanizing process, from the original record are the nucleus of the Phonogram Archives. They will last for hundreds, perhaps thousands of years, and they seem almost indestructible, even by fire. Today the Archives contain more than three thousand of them. They have been made from records taken in all parts of the world, always under scientific control.

The records are classified into four main groups: those of philological and linguistic interest, those of musical interest, "voice portraits" of well-known persons, and records of interest to students of medicine and physics. It is impossible here, of course, to give a list of all the languages in the collection, but some of the more curious ones may be mentioned; for instance, the Spanish of Paraguay, the "Spaniolish"

A German 15-inch-gage passenger train at the recent Munich Transport Exhibition

spoken by Balkan Jews, and all the existing Celtic dialects—Welsh, Irish, Gaelic, Manx and Breton.

A point has been made of securing, as far as possible, languages or dialects which are dying out. In a few years the Manx, and Basque records, for example, will be of unique historic value. Another particularly valuable set of phonograms is the collection of Sanskrit records, made in the Brahmin priest-schools by the meteorologist Felix Exner while on an expedition to India in 1904.

Among the records of the speech of primitive peoples, the Archives owe those taken among the Kalahari Bushmen, and in New Guinea, to the late Professor Rudolf Pöch, the well-known ethnographer and anthropologist. It is of the greatest importance to science that the language of the ancient race of Bushmen, now almost extinct, has been preserved from oblivion in this way. This language is of peculiar interest, and in the phonograph records the "clicks" and other characteristic sounds made by these people as a part of their speech can be plainly heard. Such records are of enormous value, not only for the student of phonetics and philology, but also for the ethnologist and student of folk-lore.

The group of musical records also covers an extremely wide field. The chief feature of the musical department so far is the wonderfully rich collection of exotic records from other lands. Papuans can be heard playing on bamboo flutes, and Zulus singing their dancing war-songs, hunting-songs, and wild laments. The plaintive sounds of the "cornemuse" of Brittany and of the Scottish bagpipes are not wanting.

One very strange series of records shows the peculiar way of chanting the Bible practised by certain Eastern Jews—a subject of study equally interesting to philologist, ethnologist, or musician. The records, of course, are very often of many-sided interest, as, for example, the Sanskrit collection, or the strange old "Regös" songs sung by Hungarian peasants on New Year's night, and thought to date from heathen times.

The third main group of the Archives' records, that containing the voices of famous persons, is small as yet, but already has historic value. Some of the speakers, notably actors, can already be distinguished by their speech as belonging to a past generation, although the oldest of the records does not go back more than twenty-four years. Thus quickly do the fashions of speech change! It is easy to see that such a gallery of "voice portraits" may be of enormous interest to both scientists and historians in the future.

Miniature Locomotives and Railroads in Europe

By the courtesy of Mr. Henry Greenly (Assoc. Inst. Loco. Engineers, England) we present the accompanying photographs and the following data of an interesting development of miniature railways and locomotives in England and on the continent. Mr. Greenly, the designer of these locomotives, who has devoted the greater part of 25 years to the development of 15-inch gage railways, writes us that he has designed miniature engines for this gage on railways operating at Eskdale, Rhyl, Margate, and that he is in close touch with Herr Roland Martens, who is carrying out similar work in Germany.

Here, in America, we think of these little locomotives as being used for pleasure, mainly for exhibition purposes at amusement parks. It will come as a surprise to many to learn that the larger part of these little fellows have been designed for, and are in use on, a commercial railroad seven miles in length which traverses one of the most beautiful valleys in the mountain district of Northern England. Starting at Ravenglass, a junction on the main broad-gage line, the 15-inch line, which has taken the place of the original 3-foot gage railroad built in 1875, is in service throughout the year, carrying passengers in the summer months, and bringing out rock and crushed stone through the winter months. This line between Ravenglass and Eskdale has proved eminently successful during the past ten years.

Mr. Greenly designed his first 15-inch gage locomotive in 1904, which was tested out on the Duke of Westminster's private railway at Eton Hall, where it carried trains of 60 passengers at 26.4 miles per hour. Six of these were built and are still running. They are of the American "Atlantic" type, with 18-inch coupled drivers and 3⅜-inch by 6-inch cylinders. Then followed a larger model with 4¼-inch by 6¾-inch cylinders and 20-inch wheels. One of these more powerful 15-inch engines was placed on the Eskdale line in 1915. It is still in service and has covered over 150,000 miles. This engine formed the basis for similar Pacific-type engines, of the type shown in our illustration with six-coupled drivers. The last carried a pressure of 180 pounds per square inch.

These later locomotives have wide fireboxes, following the American practice. Mr. Greenly states that in such small locomotives the proportion of the boiler, in relation to the cylinder capacity, should greatly exceed the figures generally accepted by makers of small-gage industrial locomotives.

The heavy passenger traffic is transferred from the main-line trains at Ravenglass Junction, and frequently over 500 passengers are unloaded at this station at once. The newer engines can deal with 260 passengers in a single train, and traverse grades of as much as 2½ percent. The latest locomotives are one-third full size, which is the accepted standard for all future 15-inch gage locomotives. Many of the trains run the whole seven miles non-stop. This is indeed a test for endurance. It is only possible by the use of ample heating surface, duplicate injectors, water gages, and tenders, holding sufficient water for the round trip. The first "Mikado" engine to be built in England was the "River Esk," with eight coupled drivers. It has hauled 270 passengers on a 30-car train. Two engines of this type, built for Count Zborowski, have made 35 miles an hour with 10 cars. At 45 percent cut-off they have developed 40 horsepower. They have hauled 34 tons up a 1 in 60 grade. Their cylinders are 5¼ by 8½ inches; drivers 25½ inches diameter; boiler pressure 180 pounds per square inch; tractive effort 1470 pounds; total weight, locomotive and tender, 178,000 pounds; total length 24 feet 9 inches; width 37 inches; height 57 inches.

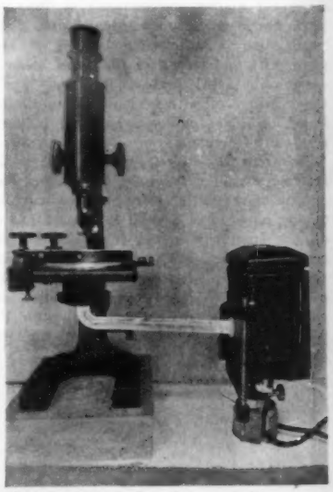
We show a view of a locomotive built by Herr Martens, from Mr. Greenly's designs, for the Transport Exhibition at Munich. Three were built, following the design of the Zborowski locomotive.

A New Way to Illuminate Microscopes

When using the compound microscope it is necessary to throw relatively strong light on the object which is being viewed. Always this has been done by means of daylight or electric light, the rays being reflected on the object either from above it or from below it.

Now that the process of making fused quartz glass in various sizes and shapes has become practicable, a new way to illuminate the object under the microscope has been found. A bent rod of the new quartz glass is placed under the object, as shown in the illustration.

If one were to do this with ordinary glass, however, so little of the light that entered the end of the tube would find its way around the corner that the arrangement



Light from the lamp follows up through the solid quartz rod, illuminating the object

would be useless. It is, however, a peculiarity of fused quartz glass that light will follow through it, around a corner—a phenomenon which is almost uncanny when observed.

The facts that quartz absorbs a very small portion of the light, and has a high melting point, make its use in this work advantageous. The light conveyed through a solid quartz rod is sufficiently brilliant to illuminate high-power objectives without the additional use of substage condensers. The rod also gives better detail than the ordinary methods of illumination. The ends of the rod are ground uniformly, but not polished. Diffused light thus obtained obviates all trouble from images of the filament. It is also possible to work farther from the light source to avoid heating of specimens.

(*Continued on page 188*)

130,000 times better

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Miss S. B. Lgiter, metallographist, in the research laboratory of the General Electric Company, has been obtaining satisfactory results with several types of clear fused quartz illuminators. For use with the ordinary small microscope, a half-inch quartz rod with a right-angle bend is used. The light source is a small moving picture lamp, with the lens removed. The intensity of the light is regulated by a rheostat. There is less loss of intensity than when the light is reflected from a substage mirror, and the light can always be directed to the stage of the microscope where wanted.

In the case of the inverted type of microscope, where illuminating a transparent specimen has presented difficulties, the use of quartz rods is especially convenient. Since intense heat does not shatter quartz, one end of the quartz rod can be placed immediately over an arc, and better illumination conveyed to the specimen.

* * *

The Einstein Theory at the Recent Meeting of the American Association for the Advancement of Science

EASILY the outstanding feature of the recent annual meeting of the *American Association for the Advancement of Science*, as the writer saw it at Kansas City, was Professor Dayton C. Miller's announcement that he had carried his previous experiments on ether drift to the extent of making over 100,000 observations, largely during the past summer, and that they apparently prove the existence of an ether drift.

The significance of this result, if it is substantiated, is that the Einstein theory must be very seriously affected. In fact, Professor Einstein, himself, makes the flat statement that, "if Dr. Miller's results should be confirmed, then the special relativity theory, with the general theory in its present form, falls." Continuing, Professor Einstein says, "Experiment is the supreme judge."

What finer example of the true, sportsmanlike spirit of the scientist who searches only for the facts rather than for a vindication of his own life work could possibly be adduced than this clear, unequivocal statement.

Professor Einstein, it will be remembered, threw out the ether of space very largely because of the negative results reached in 1887 by Professors Michelson and Morley, in which they found no ether drift. All the phenomena of nature go on, said Einstein, precisely as though there were no ether.

More recently it occurred to Professor Miller that the now famous Michelson-Morley experiment was performed in a basement, and that had there actually been an ether drift, that is, had the earth in its motion been partially dragging the ether along with it just as a ship drags along the water near its hull, it was possible that the negative results of the original experiment was because the ether was so penned in by the cellar that any existing ether drift would not have been perceptible there.

So he began a series of experiments in the open air.

Last spring he announced at the meeting of the *National Academy of Sciences* that he had actually detected and measured an ether drift, working mostly on Mt. Wilson, California, and that it amounted to about one-third of the orbital velocity of the earth.

Professor Miller's results were not, however, received by science without considerable reservation. Some scientists were inclined to pass them off rather lightly, as due, perhaps, to some systematic error in observation. So all through the past summer Professor Miller has been busy repeating his experiment under still more favorable conditions.

After making more than 100,000 observations he has now finally announced his conviction that there is absolutely a positive, systematic drift effect, which varies throughout the day as the revolution of the earth on its axis adds to or substracts from the general effect. This effect also varies according to the direction of motion of the earth in its orbit. Professor Miller finally concluded this year that all his observations were consistent with the assumption that the solar system is moving in space toward the constellation of Draco, with a velocity of more than 125 miles per second, and that as it moves, *the ether drags about* 95 *percent and slips about* 5 *percent*. This may depend, however, on local contours of the earth's surface.

In the August issue of the Scientific American we saw, on the other hand, how two other recent experiments strongly favored the Einstein theory, one being the Michelson-Gale pipe experiment, conducted last winter near Chicago, the other the spectral shift of light coming from a star known as the *Companion of Sirius*, a star having a density some 5,000 times that of water.

Thus we are now presented with a sort of dead-lock between relativity and the old conceptions. When scientists disagree, what is the layman to do? He must fold his hands and wait, perhaps for decades. Either that, or he can choose one or the other side and "root" for it, according to his temperament, and if one were to judge by many letters written to the Scientific American by bloodthirsty proponents of relativity, and by an equal number received from equally bloodthirsty opponents of this theory, it

(*Continued on page 190*)

Prof. Dayton C. Miller, whose experiments may upset the Einstein theory

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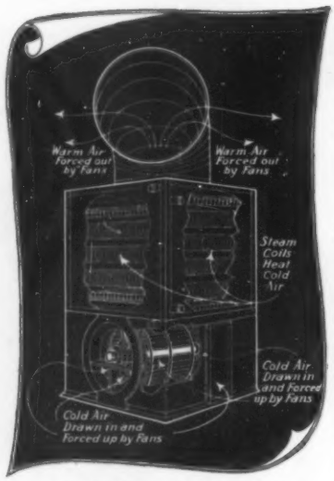
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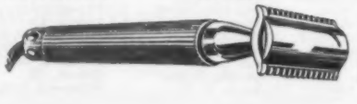


would seem as if it were temperament, rather than that calm, "wait-and-see" quality of the true scientist, that is the governing factor in the formulation of many people's opinions about relativity.

The Scientific American, however, has no set opinion about the Einstein theory, one way or the other, preferring to wait until more actual empirical work has been performed on it. This, also, is the position taken by the majority of the world's scientists.

Those who wish to read technical but brief accounts of Dr. Miller's work, up to last spring, will find it described in the *Proceedings of the National Academy of Sciences, Vol. II*, pages 306-314; the Michelson-Gale pipe experiment was described by the actual experimenters in the April, 1925, issue of the *Astrophysical Journal*, pages 137-145.

It must be remembered that the pipe experiment does not, as some have said, prove simply that there is no ether, but, in the words of Prof. J. H. Jeans, it shows that "there is no ether or else that *if there is an ether*, the earth does not drag this ether into motion by its rotation." In the latter case, there would be a flat contradiction between the work of Miller and that of Michelson and Gale.

At the recent meeting of the *American Association for the Advancement of Science*, Professor Charles E. St. John presented a paper on the astronomical evidence for gravitational displacement of spectrum lines, favoring relativity. Professor St. John is a solar physicist, and is a member of the staff of the Mt. Wilson Observatory, California. He is one of the leaders in the group that favors the Einstein theory, partly by reason of the work done by himself and by Dr. W. S. Adams, in which they detected the Einstein shift, due to the gravitation of the sun and stars.

Dr. Miller, however, displayed at Kansas City a lantern slide showing the data from which a certain curve purporting to establish the Einstein shift in the lines of the solar spectrum was drawn, and he left it to his audience to decide whether the basis of this curve, a large mass of somewhat scattered dots, was sufficiently determinative to warrant the issue of positive statements favoring the Einstein theory as were issued several months ago. From the dots obtained by the Einsteinists a curve could be drawn, without a doubt, but its definiteness did not give one an overpowering sense of proof.

A great many people, after reading yearly the numerous interesting press reports that emanate from great gatherings of scientists, such as the one referred to above, inquire what they are actually like, what the scientists do at the meetings, what sort of people they are when taken *en masse*. This, of course, is the sort of thing that does not get into the newspapers, it is too informal.

The annual meetings are held during the Christmas holidays and in selected cities. The great majority of those who attend are college professors. This year, Kansas City was chosen because it was rather farther west than usual, and this fact was reflected in the personnel of those who attended, they came very largely from the middle west and far west.

What do these men do after they get there? It would be manifestly impracticable for them to meet always in a single body, although like Congress they do meet thus once daily on the average. Like Congress, also, most of the work is done in small and more wieldy groups. For example, the mathematicians meet together; so do the physicists, the chemists, the astronomers, the geologists, the zoologists, and so on. Papers are read before groups of from 25 to 200 listeners. Usually these papers are illustrated by lantern slides. Discussions follow these papers and thus the sessions go on all day long.

At night there is usually a general lecture of some sort which would interest most of the scientists as well as the more intelligent local people. It may interest our readers to know that anyone is welcome to attend the sessions of the American Association for the Advancement of Science. Next year's meeting will be held in Philadelphia, after Christmas.

To the outsider, the scientists are ostensibly meeting only for the interchange of ideas through the formal reading of papers and through their public discussion. Actually, however, these men do not travel long distances for this purpose alone, for in a great measure this work could be covered and is actually covered by the many publications in the field of science. Therefore, it would probably be found, if any quantitative measurement were possible, that most of those who attend, do so in order to see other scientists, both in their own and in other lines of work, and to talk with them between lectures, in the hotel lobby or their rooms. They talk shop, renew old acquaintances and form new ones. And at these meetings all sorts of general scientific policies are formulated. Irritations between workers disappear when they meet thus, face to face. Everyone gets to know everyone else, not merely from his writings but by face, voice and temperament.

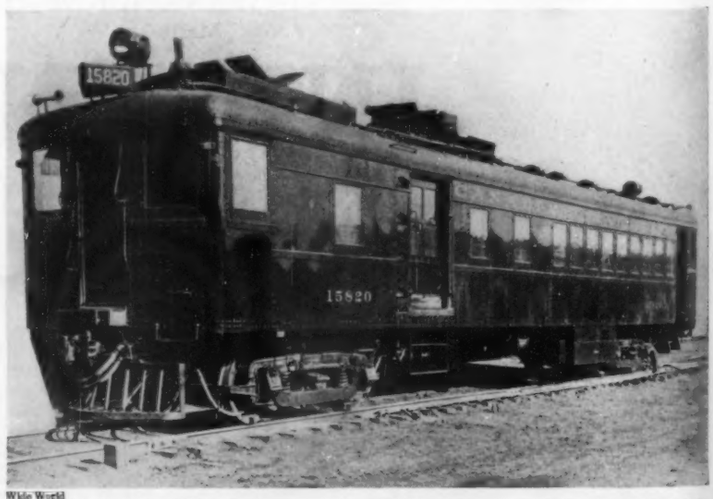
Thus, it is largely the *human* aspect of these meetings that bring men hundreds of miles to attend them.

* * *

A New Oil-Electric Railroad Car

IN making a broad survey of the field of transportation, one is increasingly impressed with the rapidity and the wide extent to which the internal-combustion engine is winning its way. So true is this, that one begins to ask whether, both by sea and land, the age of steam is not about to give way to the age of oil, as represented by the internal combustion motor.

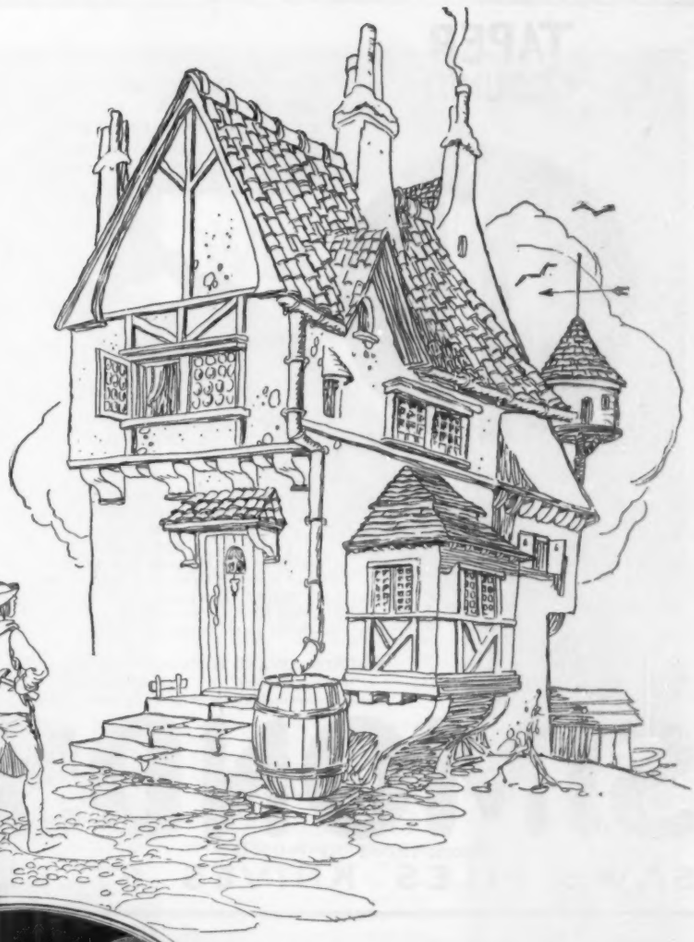
(*Continued on page 192*)



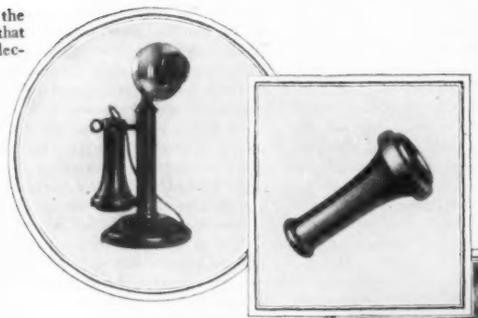
Wide World
This high-speed oil-electric car recently made a trip across Canada and back, a distance of 5,874 miles, in less than six days

"THE HOUSE THAT JACK BUILT"

— *and your telephone*

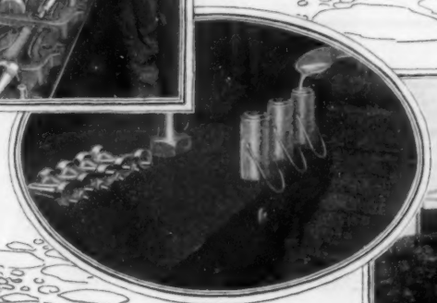


This is the telephone that Western Electric built.

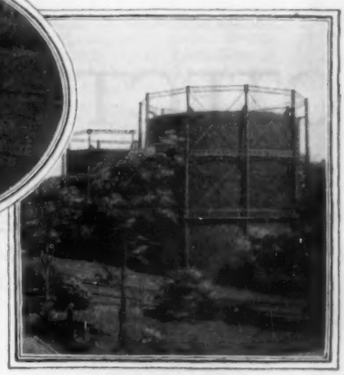


This is the shell that inclosed the receiver on the telephone that Western Electric built.

This is the mould that made the shell. . .



This is the lead that formed the mould. . . .



This is the plant that made the gas that heated the lead that formed the mould that made the shell that inclosed the receiver on the telephone that Western Electric built.

YOU recall the chain of events in the House that Jack Built—one thing leading to another? When it comes to the Telephone that Western Electric Built you find the same sort of chain.

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Incorporated under the laws of the State of New York

25 BROAD STREET
NEW YORK

In offering the above thought we are not unmindful of the great part which has been, and is indeed today, played by the electric motor, which is so extensively in use as to suggest that future historians writing on transportation will speak, distinctively of the electrical age.

We are inclined to think that the era upon which we have entered, so far from superseding the use of electric power, will enhance it, for in transportation, at least, the oil engine and the electric motor promise to become inseparable. The even torque and the marvelous flexibility of the electric motor render it an ideal reduction gear between the high-speed oil engine and the lower and ever-varying speeds required on the driving wheel of the car or the propeller of a ship, be it yacht, merchant ship or naval vessel.

No apology need be offered on behalf of the steam locomotive which has been the supreme agent in developing the world's far-flung railroad systems. For main line, express, and freight traffic it stands today at the close of its first century of operation without a rival, except for heavy trains on hilly sections of a road. Its weak point, hitherto, has been found on the score of economy; for the locomotive has acquired the reputation of being an extravagant consumer of fuel. But the very fine work which has been done in the improvement of the economy of the locomotive during the past few years has brought it up, particularly in the latest types, to a very respectable standing among other prime movers in respect of its economy, and high pressure steam, superseding the recent introduction of the water tube boiler, as seen in the "Horatio Allen," to say nothing of the improvements in valve gear, are full of high promise of economy in the future.

On the other hand, locomotive builders and users have realized for many years past, that for local and branch service, where traffic is not heavy, the steam locomotive is an extravagant form of motive power, and it is in this particular field that the internal combustion engine, when combined with the electric motor, has proved its great value.

We illustrate an oil-electric car which has been recently placed in service on certain lines of the Canadian National Railways. Two types of these cars have been developed; one a 60-foot car carried on four-wheel trucks, and the other a larger type, which is known as the articulated car, and consists of two bodies with an overall length of 102 feet, which is carried on three four-wheel trucks. Both of these types are designed for carrying passengers, express and baggage. The single passenger car accommodates 57 passengers, 18 of whom are provided with side seats in the baggage compartment. The two-body articulated car can seat 126 passengers, all of whom find room in the passenger compartments. The cars are being built at the Poynte St. Charles Shops, Montreal, of the Canadian National Railways.

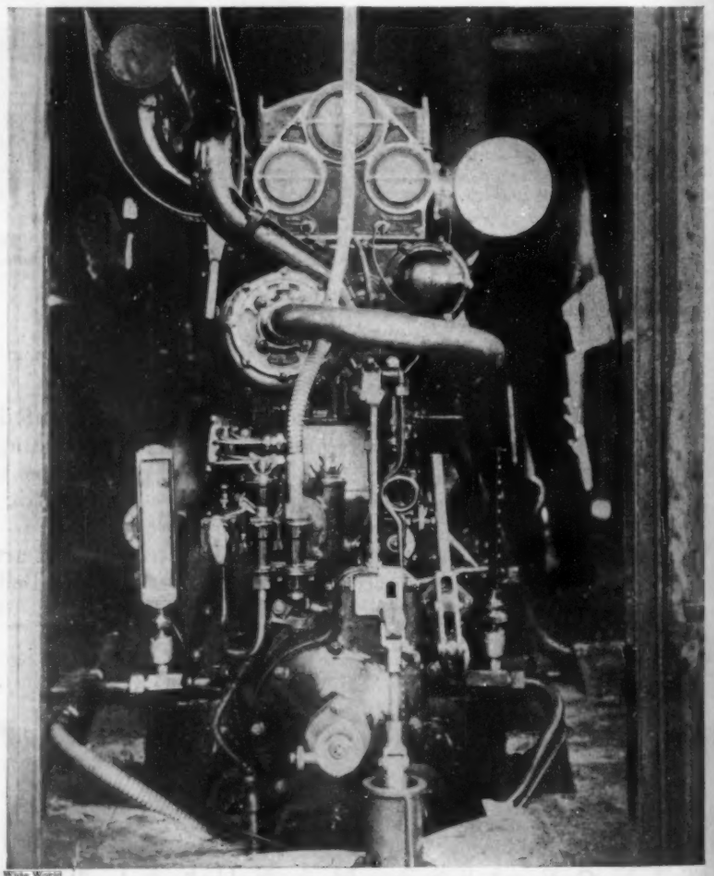
The power plant of each car is in the forward end of the baggage compartment, and it consists of an oil engine directly connected to a direct-current generator, the cars being driven by standard railway-type motors mounted as usual on the trucks. For the 60-foot car the plant consists of a modified Diesel cycle of the solid-injection four-stroke cycle type, there being four cylinders in line; for the articulated car the engine consists of eight cylinders in line.

For fuel a light residue oil of 0.86 specific gravity is used; the lubricating oil is forced under pressure to all working bearings; the oil is filtered, and before entering the tanks it circulates through a cooler on the roof.

The engine is started by the generator driven as a motor from a 300-volt battery, and the battery also supplies the control circuits at 30 volts, the generator field excitation at 300 volts, the two air compressors at 300 volts, and the air-cooling system at 30 volts.

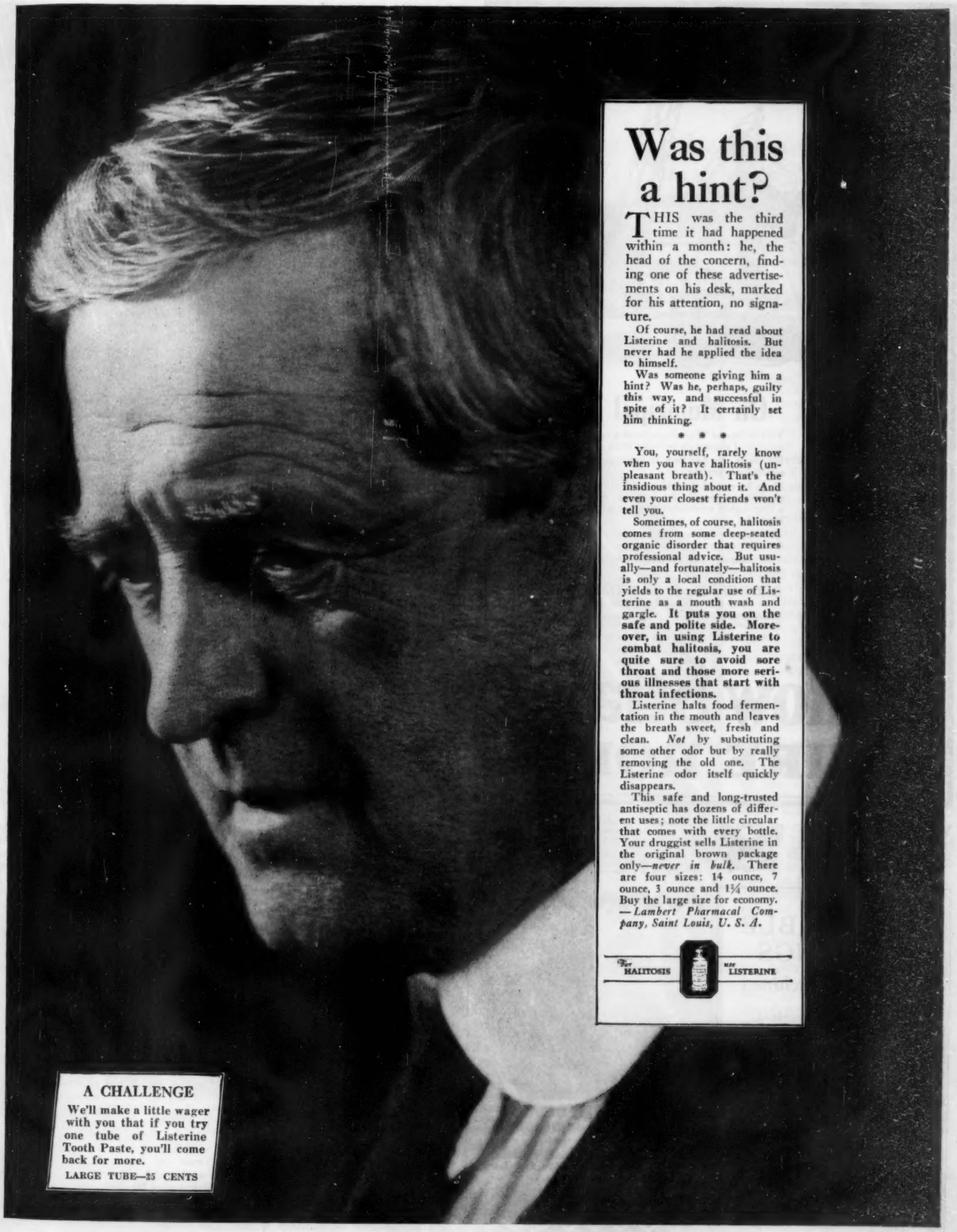
The car bodies are built of steel throughout. The inside finish is of mahogany. The articulated system originated in England, and fast express trains consisting entirely of articulated cars have been operated successfully for several years on trains running

(*Continued on page 194*)



Wide World

The Diesel engine which drove the oil-electric car shown on page 190. During the entire run of 5,874 miles this engine never stopped running



Was this a hint?

THIS was the third time it had happened within a month: he, the head of the concern, finding one of these advertisements on his desk, marked for his attention, no signature.

Of course, he had read about Listerine and halitosis. But never had he applied the idea to himself.

Was someone giving him a hint? Was he, perhaps, guilty this way, and successful in spite of it? It certainly set him thinking.

* * *

You, yourself, rarely know when you have halitosis (unpleasant breath). That's the insidious thing about it. And even your closest friends won't tell you.

Sometimes, of course, halitosis comes from some deep-seated organic disorder that requires professional advice. But usually—and fortunately—halitosis is only a local condition that yields to the regular use of Listerine as a mouth wash and gargle. **It puts you on the safe and polite side. Moreover, in using Listerine to combat halitosis, you are quite sure to avoid sore throat and those more serious illnesses that start with throat infections.**

Listerine halts food fermentation in the mouth and leaves the breath sweet, fresh and clean. *Not* by substituting some other odor but by really removing the old one. The Listerine odor itself quickly disappears.

This safe and long-trusted antiseptic has dozens of different uses; note the little circular that comes with every bottle. Your druggist sells Listerine in the original brown package only—*never in bulk.* There are four sizes: 14 ounce, 7 ounce, 3 ounce and 1¼ ounce. Buy the large size for economy.

—*Lambert Pharmacal Company, Saint Louis, U. S. A.*

For HALITOSIS use LISTERINE

A CHALLENGE

We'll make a little wager with you that if you try one tube of Listerine Tooth Paste, you'll come back for more.

LARGE TUBE—25 CENTS

On Municipal Docks

Yellow Strand Wire Rope lends a helping hand in the transfer of shipments between dock and river barges.

Big loads are handled as safely as little ones and economy is certain.

Made by one of the oldest wire rope manufacturers, virtually pioneers in the industry, Yellow Strand has a thoroughly established reputation for strength and long life.

The strand of *yellow* is the quality mark of Yellow Strand—and your protection.

This company also makes all standard grades of wire rope for all purposes.

Motorists

Carry a Baaline Autowline in your car and safeguard your spare tire with Powersteel Autowlock. Both are made of Yellow Strand. Ask your accessory dealer.

BRODERICK & BASCOM ROPE CO.
843 North First Street, St. Louis, Mo.

Eastern Office and Warehouse: 76 Warren St., New York City
Western Office: Seattle *Factories:* St. Louis and Seattle

Authorized Dealers in all Industrial Localities

Yellow Strand
WIRE ROPE

JR434

WHY NOT spend Spring, Summer and Fall gathering butterflies, insects? I buy hundreds of kinds for collections. Some worth $1 to $7 each. Simple outdoor work with my instructions, pictures, price-list, fiend 10 cents (not stamps) for my illustrated Prospectus before sending butterflies.
MR. SINCLAIR, DEALER IN INSECTS,
Dept. 36, Box 1424, San Diego, Cal.

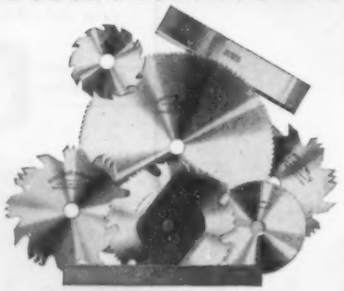
KINKADE GARDEN TRACTOR
AND POWER LAWNMOWER
A Practical, Proven Power Cultivator for Gardeners, Suburbanites, Truckers, Florists, Nurserymen, Fruit Growers.
American Farm Machine Co.
1057 33rd Av. S.E., Minneapolis, Minn.

MALLEABLE CASTINGS

Rough or Machined

We specialize on machined malleables in quantity production. Many users who operate large machine shops in connection with their business find it to their advantage to buy of us. Perhaps you could do likewise.

BENTON HARBOR MALLEABLE FOUNDRY CO.
Benton Harbor Michigan



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3 to 6 inch sizes
Specialties for small cutting and grooving. Write for information and prices.
Huther Bros. Saw Mfg. Co.
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Makers of Better Saws for More Than Fifty Years

from London to the north. On the articulated car under discussion the center truck supports one end of both the front and the rear car bodies. At the junction each body carries a cast-steel end sill, to which are bolted male and female center castings, one resting within the other and both engaging the truck center plate.

Both the single and articulated cars have maintained a speed on level track of about 60 miles an hour, and the fuel consumption for non-stop runs worked out as 3.5 miles to the imperial gallon on the large car, and 7 miles to the gallon on the small car. In a test of the single car a run was made from Montreal to Toronto, 334 miles, in 8 hours and 30 minutes, the engine running continuously throughout the trip. The cost of the fuel oil used on this trip was about $3.50, and of the lubricating oil 48 cents. Another remarkable run was made from Montreal to Vancouver, a distance of 2,937 miles, in 72 hours total and 67 hours actual running time, at an average speed of 43.8 miles per hour. The oil-engine, it should be noted, ran continuously for the whole 72 hours. The car consumed .206 imperial gallons per mile, at .266 cents per mile.

The Heavens in March

By Professor Henry Norris Russell, Ph. D.

At 11 o'clock: Mar. 8
At 10½ o'clock: Mar. 16
At 10 o'clock: Mar. 23
At 9½ o'clock: Mar. 29
At 9 o'clock: April 7
At 8½ o'clock: April 14
At 8 o'clock: April 22

NIGHT SKY: MARCH AND APRIL

The Heavens

ALL four of the prominent clusters which are mentioned in the article on p. 157 are now in full view, and all may be found upon our map. At the stated hour, the Pleiades are low in the west, northwest and the Hyades not far away—at an equal altitude, and a little to the left—marked by the bright star Aldeberan. The Praesepe cluster is high in the southwest, about midway between Gemini and Leo, while Coma Berenices is well up in the east above Arcturus. To the naked eye, Praesepe is but a hazy blue, but the individual stars of the other three groups are easily seen.

The winter constellations are still in sight, but we shall soon lose them. Taurus, Orion and Canis Major are all low in the west and southwest. Auriga, Gemini and Canis Minor are above them. Leo is high in the south with Hydra below, and Virgo, Crater and Corvus are in the southeast. Boötes, Corona and Hercules are in the east and northeast. Ursa Major, high in the north with Draco and Ursa Minor below and Cassiopeia and Cepheus on the horizon.

The Planets

Mercury is an evening star this month and can be best seen on or about the 14th, when he is farthest from the sun. Being close to perihelion, his elongation is small, only 18 degrees, but this is compensated for by unusual brightness and by a favorable position north of the sun. He remains above the horizon till 7:30 P.M.

Venus is now a morning star and at her greatest brilliancy. She rises about 4:40 A.M. on the first and 3:50 on the 31st and is the chief ornament of the morning sky.

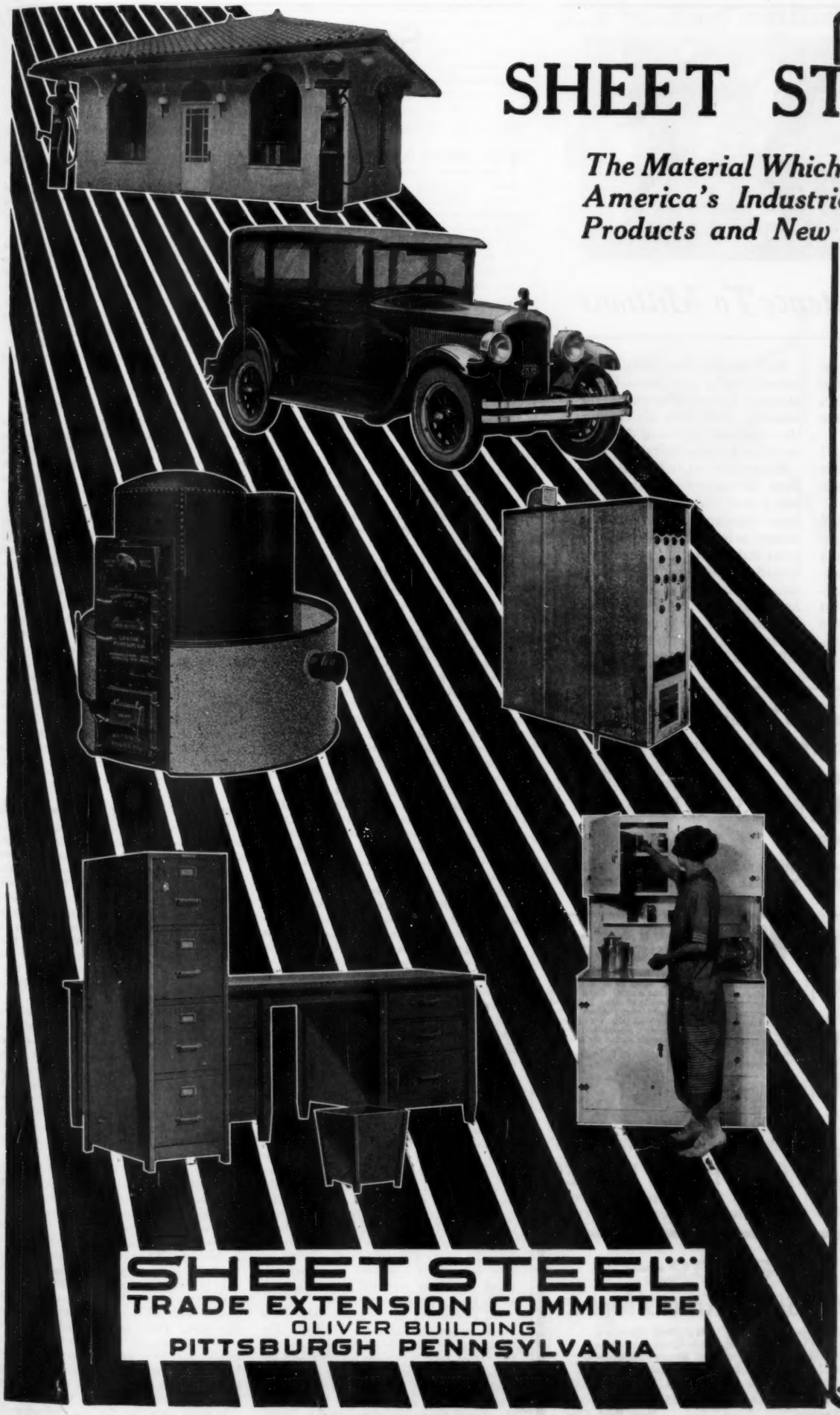
Mars is a morning star, too—rising at 3:30 A.M. in the middle of the month, but is still more than 150,000,000 miles away and looks only about as bright as Antares. Jupiter is a morning star like the others and rises at 4:45 on the 15th. He is in conjunction with Venus on the 22nd, but, even at their nearest, the planets are almost five degrees apart.

Saturn is in Libra and comes to the meridian about 4 A.M. Uranus is in conjunction with the sun on the 17th and is invisible. Neptune is not long past opposition and is well observable telescopically.

The moon is in her last quarter at 7 A.M. on the 7th, new at 10 P.M. on the 13th, in her first quarter just after midnight on the 21st and full at 5 A.M. on the 29th. She is nearest the earth on the 12th and farthest away on the 25th.

During the month, she is in conjunction with Saturn on the 5th, Mars on the 9th, Venus and Jupiter on the 11th, Uranus on the 14th, Mercury on the 15th, and Neptune on the 25th.

At 4 A.M. on the 21st the sun crosses the celestial equator and passes over the vernal equinox; wherefore, in almanac language, "Spring commences."



SHEET STEEL

The Material Which is Giving America's Industries Better Products and New Markets.

Everywhere manufacturers are facing these problems—How can a better product be built that is practical? How can new markets be obtained?

Many of them will find the answer to both questions in Sheet Steel. Ford is said to have found that each time the price was lowered fifty dollars it added 1,500,000 more potential customers in this country alone. Sheet Steel enabled him time and again to extend his markets through greater economy. The recent announcement of All-Steel cars in both open and closed models, has been the natural result.

Sheet Steel office files have virtually done away with other types. Their compact construction, greater strength, rugged durability and fire-safeness have made them the universal choice. And now Sheet Steel is being adopted for other office furniture as well, from desks to waste paper baskets, from partitions to employes' clothes lockers.

Hotels, hospitals and residences, too, are turning to Sheet Steel for their furniture requirements. It offers increased sanitation, it is easily cleaned and its beauty endures the most severe tests of use and abuse. Today Sheet Steel finishes in either wood grains or flat enamels can be had which resist smoke, water and dirt. A bottle of perfume may be spilled on a steel dresser top without damage. A cigarette can burn itself out on the polished surface without a trace.

Manufacturers and designers will do well to study the many applications that are being made in Sheet Steel. Many of these have brought about new production methods that offer possibilities undreamed of a decade ago. Through proper standardization and organized large-scale operations they permit offering the buyer better products and better values.

A magazine called "MAKING MARKETS" is published by the Committee for the benefit of manufacturers and designers. If you are not now receiving copies they will be mailed you regularly on request.

SHEET STEEL...
TRADE EXTENSION COMMITTEE
OLIVER BUILDING
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From One Sentence To Millions

ON MARCH 10, 1876, a single sentence was heard over the telephone. Now, after half a century, 50,000,000 conversations are heard each day.

"Mr. Watson, come here; I want you," spoken by Alexander Graham Bell, the inventor, was the first sentence.

His first crude instruments had been tested by sounds and single words; the patent had been granted; the principle was established from which a world of telephones has since resulted. But at that time the telephone had not proved its practical usefulness—its power to command.

Bell's words, electrically transmitted over a wire, brought his assistant from another part of the building. And with his coming, the telephone became a dynamic factor in human affairs.

Since that first call untold millions of sentences have been heard over the telephone. Men have traveled vast distances in answer to its calls. The wheels of great industrial enterprises have turned at its commands. Everything that man can say to man has been carried to a distance over its wires and the thoughts and actions of nations have been influenced through its use.

AMERICAN TELEPHONE AND TELEGRAPH COMPANY
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BELL SYSTEM

IN ITS SEMI-CENTENNIAL YEAR THE BELL SYSTEM LOOKS FORWARD TO CONTINUED PROGRESS IN TELEPHONE COMMUNICATION

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"SOLUBLE" TREATMENTS PETRIFY

UNISOL, uniform, correct, soluble-under-all-temperatures boiler feed water treatment invariably proves successful; while in all cases *INSOLUBLE* "soluble" treatments PETRIFY:—RESULT—adhesion, scale, burning, repairs: FIRST CLASS FAILURE.

UNISOL produces desired results throughout the world—WHY? Because it is not detrimental: IT IS SOLUBLE.

Fifteen years of observation and application prove it: BOILERS PROVE IT.

Success depends upon solubility. GIVE BOILER FEED WATER AND BOILERS PROPER TREATMENT. Pamphlet on request.

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WITTE LOG & TREE Saw

Cuts down trees and saws them up FAST—one man does the work of ten—saws 10 to 25 cords a day. Makes ties. A one-man outfit. Easy to run and trouble-proof. Thousands in use. Powerful engine runs other farm machinery. Uses Kerosene, Gasoline, Distillate or Gas-Oil. Completely equipped with W1CO Magneto, speed and power regulator, throttling governor and 2 fly wheels.

Easy Payments Pay only a few dollars down and take a year for balance of low price. Make your own terms. One-profit—sold direct from factory to you.

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475 Eighth Avenue - New York City

Science and Money

The Oil Industry

By Henry C. Trundle

THE high mark in crude oil production in the United States was reached in 1925 when 758,500,000 barrels were obtained. Twenty years ago this country's consumption amounted to only about 100,000,000 barrels. Thus has the tremendous growth in the number of automobiles and the general use of oil for power, heat and light made this product of front-page importance. Discoveries of new fields and improved production knowledge have taken from oil some of its romance, and have made it a respectable industrial commodity.

Despite heavy production in each of the past few years, with the largest increases in 1923 and 1924, the year 1925 closed with the industry in a better condition than it has occupied since 1920. Consumption demand, like the demand for autos, had run much ahead of forecasts, so that there was a smaller carry-over to stocks. Prices of crude oil were practically stabilized. When it came time to prepare reviews for the year, commentators confined themselves mostly to laudatory remarks on the excellent current position of the industry and to conjectures concerning prospective company mergers within it.

Science and Oil Production

At one time oil production was carried on very haphazardly, but such ways have been discarded in favor of the scientific methods of the geologist and the petroleum engineer, who are sponsored by financially able concerns. Stories regarding the work of these prospectors in domestic and foreign fields are featured items in newspapers and magazines. For the most part the industry is now in the hands of huge corporations, whose affairs are subject to the closest scrutiny. Rumors of malpractices have been rampant, so that the word "oil" is often associated with political scandal. In recent years our government has been disturbed by the disclosures brought to the public's attention through various investigations, and for a time some sort of an international fracas seemed imminent. It is therefore encouraging to read that the industry is now on a sound basis.

Since oil is of such major importance and its continued supply a matter of conjecture, a great deal of study has been made to determine its source, the nature of its constituents and the probabilities for a larger production to meet a growing market. Several theories have been advanced as to the origin of oil, all based logically on apparently sound propositions. For some time it was thought that petroleum was formed by inorganic agencies, which depended upon volcanic phenomena. Chemists, through laboratory tests, proved to their satisfaction that this was the case.

Oil Where Life Was Abundant

The belief was that the core of the earth was composed largely of the carbides of the common metals (especially iron), and that chemical reaction took place as water penetrated to that depth. The resultant gases were thought to seep through cracks to the surface and to cool there as a liquid. This theory, at first hard to disprove, has now been replaced by the organic theory which forms the basis for most new geologic investigations. Those who hold to this theory believe that oil is converted from materials which have been deposited in certain areas at the time of geological changes.

Oil is expected to be found only where life is known to have been abundant. The color of rocks, their chemical nature and the manner of their formation are therefore important items. So difficult is it to analyze the mother substance of oil that the organic theory has been grouped under two heads—the animal theory and the vegetable theory. That oil is found almost entirely where animal and plant life has been dense gives credence to these viewpoints.

The oil industry has come to be regarded as separable into the following divisions: (1) production; (2) transportation; (3) refining; (4) marketing.

Some companies confine their operations to one phase of the business, while the present tendency toward stabilization in production and price has led to other companies undertaking all four functions as a part of their organization. The current activity in regard to consolidations is in line with this policy and will have a positive effect in the establishment of the industry upon recognized economic principles.

Geological Data Necessary

Before wells can be worked, oil must be found. If the geological structure of the entire world were known and recorded there would be little need for extensive scientific expeditions to distant lands. For the most part domestic fields are known, and are owned or leased by the major companies, which fact precludes in a measure the possibility of some group gaining quick wealth through a new discovery. It is the usual practice to lease, or to obtain the right to drill upon any lands where the presence of oil is suspected. It is less expensive to carry a lease for large areas for years than it would be to purchase the same lands after oil is found there. Sometimes land is purchased outright from the individual or government, or it is exploited under an equitable arrangement. Frequently the larger companies have access to a wide area through the ownership or lease of plots arranged in checkerboard fashion, the land thus being held in alternate squares. This is more satisfactory than holding a solid block, since a much larger area can be advantageously controlled with the same capital outlay.

Methods of Drilling and Transporting

In the United States the most productive field has been California, where, in 1925, 231,673,000 barrels were produced, or over one-third the country's entire output. Texas, Oklahoma, Wyoming, Kansas, West Virginia, Louisiana, Pennsylvania, Ohio and Kentucky are the other chief producing states. Mexico, perhaps more than any other country, is known to us for its oil. Venezuela, Peru and Colombia, in South America, are likewise important. In the Old World, fields are found in Russia, Rumania, Egypt, Persia, Mesopotamia, India and Japan.

Actual drilling operations are considered either as wildcat operations or as production drilling. Wildcat operations are entered upon because of "hunches," or are so regarded because of the lack of proper geological knowledge. Production drilling is the work of sinking wells in predetermined areas. The old-time method of hand drilling has been supplanted by machine drills and various systems have been developed to utilize these to the best advantage.

While the work of locating and producing crude oil is highly colored with romance, the other stages in making the finished product available to the consumer are not without their own colorful aspects. At first it was necessary to transport oil in small barrels or in bottles. When the Pennsylvania pools were opened up it was estimated that there were in operation more than 6,000 carts, each drawn by a team of horses. Next came cumbersome railroad box-car shipments and short pipe lines. Today we are familiar with railroad tank cars of steel construction, and with a capacity of over 100 barrels each. Our harbors are visited frequently with huge tank ships, the larger tankers, plying between the Pacific and the Atlantic coasts.

In many ways the pipe line appears as the logical method for transporting oil from the

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field to the large markets or to storage places. Except for short lines, between pools or to shipping points, the pipe-line system, however, has not been generally adopted except in the United States. Here a trunk-line system has been developed connecting the productive areas in Texas with the consumer in New York, as well as points intermediary. Perhaps the largest line other than this is the line between Baku and Batoum, on the Black Sea, which was 600 miles long, and now believed to have been destroyed by recent revolutions.

Storage a Problem

The problem of storage naturally arises with the consideration of transportation. At the present time it is the practice to store oil in tanks which average between 40,000 and 80,000 barrels in capacity. In the largest producing areas will be found concrete-lined reservoirs to hold 100,000 to 5,000,000 barrels. Because of the danger from fires, it is advisable to utilize the smaller tanks; thus a cluster of these is located usually not far from retail districts.

So far we have been concerned with oil only in the crude state, which is of little value to the average consumer. The extraction from crude oil of its various products—benzine, naphthene, kerosene, gasoline and dozens of others—is the work of refineries, and while these products are obtained simultaneously, they require distinct operations. One needs to be well up on one's chemistry to understand how but slightly different conditions result in the various familiar oils. The first procedure is to physically separate the several fractions contained in crude oils. This is done usually through distillation and condensation, although the processes of cold pressing, cold settling, centrifuging and sweating are used.

Study the Offerings Made

Refining plants are designed to treat the particular crude oils that come to them so that the proper products will be obtained. Gasoline, naphtha and kerosene need to be in a highly purified state, while the solid fuels need not be purified. The stills, usually five or six in number, are so arranged that the oil flows by gravity from one to another, the desired fractions being removed at the proper instant.

The astounding growth in demand for gasoline, together with the rapid rise in price, has been the impetus for much experimental work directed toward an increased production. The result has been many new processes, the most important of which is cracking, or the breaking up of heavier oils through pressure under certain time, temperature and catalytic conditions. Full use of this procedure is now hampered by various patent suits.

The ultimate aim of the oil man is to place the finished product in the consumer's hands. This phase of the business is not complicated by chemical formulas such as are encountered in studying refinery operations, and is perhaps the branch most familiar to the public. Competition has made it necessary that the selling and distributing organizations be efficient to the extreme. Most refineries sell their output direct to retailers, and their problem is not so much one of sales as one of delivery. Refineries are located naturally near their markets or close to adequate shipping facilities.

Is there anyone who at some time has not dreamed of sudden wealth through oil? Because of the known instances of great wealth that has come out of the industry to a very few, and because the dramatic elements are present, oil stocks have carried an enormous appeal. Probably more money has been lost by the public in oil stocks than has been actually made by the operators.

Oil, clearly, is an essential commodity, and the business of production and sale a legitimate one. The industry does not deserve the speculative stigma clinging to it. Investors will therefore improve the investment side of the oil business if they will really study the offerings made them, rather than pour out their money indiscriminately.

... a heating method that actually

Forces HEAT all over your BUILDING

A Ventura fan driven by a fully enclosed industrial type electric motor insures a definite positive air circulation through the heater—enables the amount of heat to be regulated and actually forces the heat over a wide area in the direction desired.

Heat is forced over the highly efficient Aerofin heating coils (described below) into the areas to be heated and not in one corner of the room or against the wall. This feature in itself is worth the price of the Venturafin Method of Heating—it reduces heat loss to a minimum, enables the Venturafin Method to heat up more quickly at any time—makes it possible to keep even temperatures over large areas—and aids ventilation.

The Aerofin heating coil is made of tubes of copper end brass, each tube helically wound with a continuous fin. By this construction, which is patented, the heat transmitting surface of the tubes are made nearly five times greater which not only gives you greater heating efficiency, but also reduces fuel costs materially and enables a light compact unit to do the work of an otherwise large and bulky unit.

A recirculating box completes the Venturafin unit—it takes the air off the floor and feeds it to the fan whence it is forced over the heating coils and back into circulation. The complete unit represents the most scientific method of industrial heating. It is based on sound, proven principles and can be used with either steam or hot water

The Venturafin Method of Heating

And this sound, proven method of heating can be purchased cheaper than ordinary heating equipment and the installation and maintenance costs are lower.

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We have been using Dumore motors for over a year and find them adaptable to our purpose and rendering satisfactory service. We have tested out, during the last year, about ten other motors and are convinced that the Dumore is the best small universal motor on the market. We have not had one case of motor trouble for the last six months and we do not anticipate any.
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⅛ h.p. Cast iron frame. Enamel finish. Babbitt bearings, wick oil feed. Operates on A.C. or D.C.
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Nature in a Playful Mood

The cyclone at Murphysboro, Illinois, recently produced many freakish results, one of which is shown in the accompanying photograph enclosed with a note from our correspondent:

"This tree stood in the Logan school yard at Murphysboro, Illinois.

"The 1 by 10 board was driven into the tree by the cyclone that devastated Murphysboro, Illinois, March 18, 1925, about 3 P. M.

"The board hit the tree about seven feet from the ground and is so firmly driven into the tree by the velocity and force of the wind that it bore the weight of a 150-pound man hanging on it without loosening it in the least.

"In the top of the tree is a carpenter's horse also blown into the tree by the force of the wind."

Dr. Prince Comments Further on Spirit Photographs

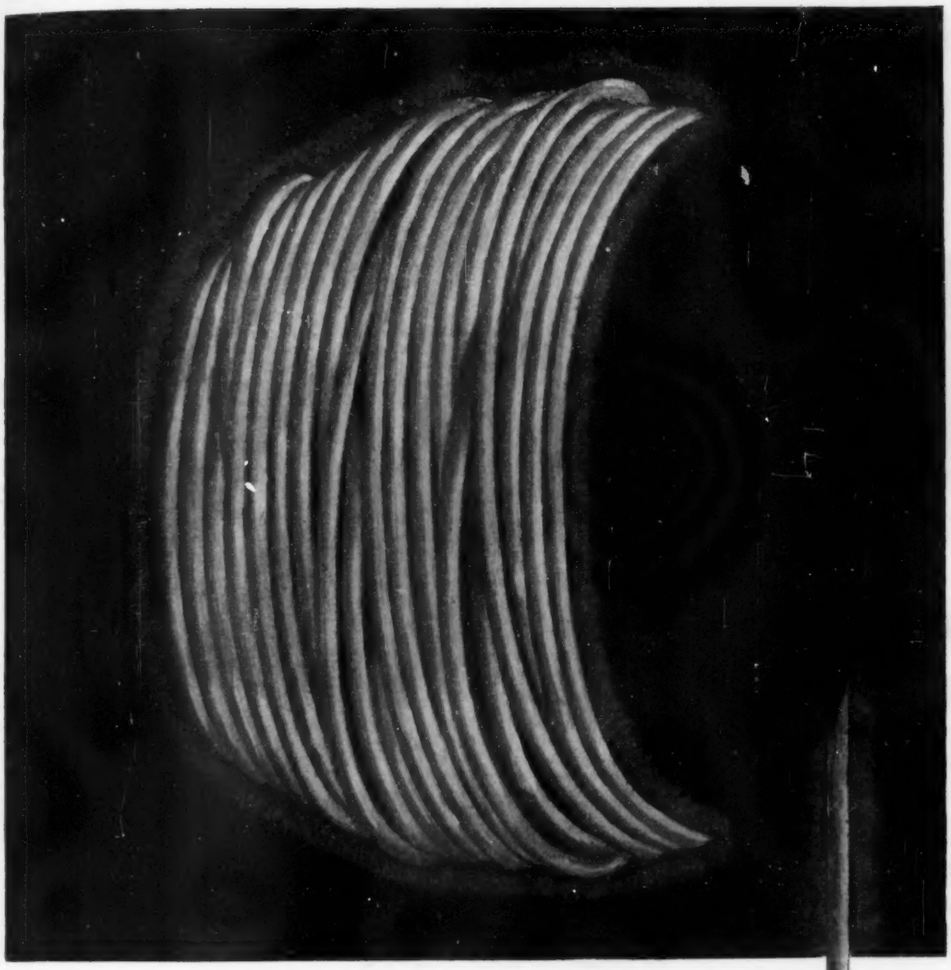
Some days before our February issue, in which we published a letter from Sir Arthur Conan Doyle, appeared on the newsstands, we received an item from Dr. Walter Franklin Prince, author of the article on spirit photographs in our December issue. He has called the item "A Footnote"—and it is a reply to Sir Arthur's comments on his article which had come to him from various sources.

Since my article entitled "My Doubts About Spirit Photographs" appeared in the December Scientific American, I have received and am still receiving many press clippings from this country and the British Islands, professing to quote from Sir Arthur Conan Doyle to the effect that I am "hopelessly prejudiced," "always doing this kind of thing," "have quoted him wrongly," "was not the first one to expose the Murillo fake," et cetera.

It happens that I am so superlatively cautious in my allegations as to facts and in my phraseology that, so far as I can recollect, no statement of mine in relation to psychic research has ever been convicted of error, so long as attention has been limited to what I actually said. But I have a number of times been branded as "prejudiced," "unfair," having "much to learn," and the like, by means of a process of diverting attention to irrelevant details and intimating that they were an integral part of my original statement. It may be interesting to readers to see how the reporter of exact facts was made to appear a sinner, first in relation to the Murillo forgery, and secondly as to the fake photograph of the "spirits" of Chicago firemen exhibited by Sir Arthur upon the screen in New York.

(Continued on page 200)

What a cyclone can do. Note the saw horse also blown into the tree by the wind



In the Timken Steel Mill, reels of hot metal like this represent millions of bearing rolls, in long pieces. Later the rolls are cut, shaped and finished. Every process, from the very production of the steel itself, is carried on in the great self-contained Timken plant.

Miles of Might for Motor Cars

Reels of rolls! Those little rolls in the Timken Tapered Roller Bearings of your car are spun by the mile in the great Timken steel mill. This is the mill with the largest output of electric furnace steel in the world. It is the only steel mill directly a part of the resources of a bearing plant.

What self-sufficient completeness—what massive operations—when bearings are hardly so much as 1% of the weight of a motor vehicle. But Timken Bearings so surely improve cars and trucks that 132,000 Timkens per day are added to the 150,000,000 of them already in use!

Permanence, silence, simplicity, and economy are the coveted characteristics which Timken Bearings assure in transmissions, in differentials, on pinion and worm gears, in rear wheels and front wheels, in steering pivots and in fans. Most largely responsible are Timken positive roll alignment, Timken capacity for both vertical and horizontal stresses, and Timken steel from Timken furnaces, as well.

Since 83% of all makes of motor vehicles in America use Timken Bearings, you can easily choose from among Timken-equipped automobiles and trucks.

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At what rate do *you* run *your* brain?

DO you realize how much more *you* could *do* and *earn* if you gave yourself a real chance — if, for instance, you knew the secret of fifteen minutes a day?

Which of these men is most like you? The laborer, shoveling coal all his days? Or the skilled man, working hard for eight hours but making no real progress? Or the factory superintendent, who has a little more leisure and hope? Or the really big man, whose earning capacity has *no* limit, and who gets more interesting play and recreation into his life than all the others put together?

Said Emerson: "Any man with an ordinary common brain can make good if he has the willingness to run that brain up to 80 per cent of its highest efficiency."

The secret of running your brain up to 80 per cent or more of its true capacity is no longer a secret, in the true sense of the word. For over 400,000 ambitious people have learned it, and put it to work for themselves.

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I. Sir Arthur says that I was belated in my discovery of the Murillo imposture, since he inserted a certain article in *Light* six weeks before my article was printed. But my article was in the hands of the editor two weeks before that, and, moreover, it was another picture which Doyle announced in *Light* that he detected, not the one to which I referred. My expression of wonder whether I was the first to discover the Murillo imposture had reference to the fact that it had passed the inspection of Doyle and many others long enough to get into the *International Psychic Gazette*. Of course, I did not expect to be the only one who would ever make the discovery, nor did I regard the priority of mine as any part of the issue.

Sir Arthur says that I misquote him; that he did not say that the picture was "the most remarkable spirit photograph" he had ever seen, but that it was "the most artistic." But I did not say that he said it, but that the *International Psychic Gazette* said he said it, which was true.

Thus, by magnifying details, and by wrongly relating them to me, attention is diverted from all that I deemed important, and all I emphasized, namely, that a clumsy and brazen photographic fraud passed the inspection of Spiritualists long enough to be reproduced as a proof of spirit action, in one of their prominent magazines, that Murillo's conception of the Deity was "recognized" by a woman as her "spirit guide," St. John, and that four of his conventional cherubs were "recognized" by four mothers as their respective children.

(The *International Psychic Gazette* has since said that I ought to know that spirits are capable of making a "reproduction of existing paintings." In the present case this would mean that spirits carefully cut away two-fifths of the "Holy Family," and blocked out the betraying dove with cotton batting so thick that its edge casts a shadow. I should say that if spirits are so anxious to prove their work a fraud they should be accommodated.)

II. As to the fake spirit photograph shown in New York:

Sir Arthur tells us that in showing this picture on the screen he did not say it was genuine, and that he withdrew it after I communicated with him. This is exactly what I stated in my article. The reason I related the story was that I felt that such portion of the public as think that the distinguished novelist, since he invented Sherlock Holmes, must himself possess superior detective instinct should, in view of his bitterness against the (English) Society for Psychical Research and those who preserve its traditional policy of caution, recognize that he has an easy intellectual conscience. He knew nothing about the history of the fireman picture; and yet he showed it in his public exhibit of choice proofs. And even now he says he is not sure that it is not genuine, although I let him read the original letters of Fallis, the Chicago photographer, who made it to prove to Dr. Hodgson how easily a "spirit" photograph could be made.

I have stated what was the important point in connection with this part of my article. Again it is sought to divert attention from the real issue, and to fix it upon an irrelevant detail. Had it been shown that I had misstated a single detail, that would have been to the point. But no, it is intimated that I am not a gentleman, because I did not keep the matter a secret forever, as I kindly did at the time in order that the novelist's lecture tour should not be less successful. I believe that, in connection with psychic research or this particular incident, whether I am a gentleman or not, like the question whether my nose is becoming, is an irrelevant detail. To be sure, I did not understand that I was obligated or expected to be forever silent on the little matter. I have no such secrets concerning myself, and anyone is at liberty to tell the truth about me at any time.

It is not "prejudice" to state irrefutable facts, nor "unfair" to quote with exactitude, although I admit that "Dr. Prince is always doing this kind of thing." But it is getting so that to have vision, memory and logical faculty enough to expose pretentious and blatant frauds is regarded by the resolute devout as evidence of a soul filled with all iniquity.

Walter Franklin Prince.

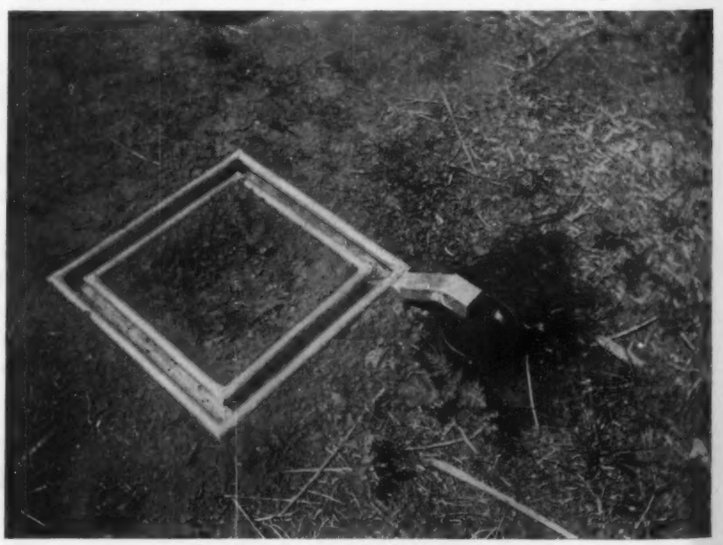
Kill the Ant!

Here is a clever device, guaranteed to catch and kill red ants. Our correspondent describes the process by which these pests climb up the perforated spout, there to fall off to their death.

A trap guaranteed to catch and kill red, cutting ants has been invented by a Texas man. The trap is a square trough, about an inch deep, with an elevated spout at one corner. The ants climb up the spout and fall into a pan of kerosene oil which kills them. The device, which occupies only a square foot of space, is set by being intrenched around the hole in such a manner that the insects fall into the trough either when leaving the hole in search of food or when returning after foraging.

In setting the trap, care must be taken to bank the dirt up against the sides so that the ants will tumble in when trying to enter or reach their bed. The curved-in sides prevent the ants climbing out, while the perforated floor of the spout makes it possible for them to ascend it with ease, only to fall into the oil. The accompanying picture shows one of the traps set around an ant bed, with hundreds of dead ants piled up near the can. Several holes in the bottom of the trough will provide escape for rain water that might fall in it. The trap is not guaranteed to catch small sugar ants which, because of their size and light weight, can climb out.

These traps are made of ordinary sheet tin covered with a coating to make it



An ingenious trap for killing red ants

slippery. Pieces are first cut for the sides and spout on a standard cutting knife. Then these pieces, cut in exact sizes, are run one at a time through a series of machines operated by hand cranks. Each machine performs a specific operation, such as perforating the bottoms, bending the sides, and cutting a hole in one side for the spout. Sector gears, cutting dies, scavenger springs and heavy weights are the principal parts of the machines, which were also invented by the inventor of the trap. After the pieces have been cut and bent into shape, they are soldered together to form the completed trap.

Lee Woods.

A Novel Fertilizer

One of our friends in Guatemala sends the following: Radio fans may be interested in figuring out just what reaction takes place in the gap between the ground and the end of the antenna.

Editor, Scientific American:

You may be interested in the experiments I have been making in stimulating plants by means of electricity from the atmosphere.

The lime tree which was rejuvenated by means of atmospheric electricity

Plants are natural lightning conductors, as the points of the leaves and needles place themselves in electrical connection with the atmosphere. After each electrical storm it may be noted that the plants obtain new vigor and growth. Therefore, if the stem and branches of the plant are provided with copper wires adjusted in two or three places by means of narrow copper bands and if the upper ends extend toward the atmosphere in the form of small lightning conductors, the plant remains in direct contact with the electricity of the atmosphere and will be stimulated in such a way that it will produce a great quantity of new flowers and fruits. The fruit is of far better appearance and of better quality on account of this device.

My first experiment was made with a young guava tree. After having placed an antenna on this tree during the months of March to June of this year it made several new shoots; it has flowered and produced fruit twice and the fruits are twice the size of the ordinary fruit and are much sweeter. During these months we had many electrical storms.

On the 15th of July of this year I experimented with an old lime tree. The fruits of this tree were dried up before they were much good. In order to obtain a better result I placed three antennas of copper wire in the tree, also surrounding some of the branches and also I placed an antenna of loose copper wire. These antennas consisted of 50 turns around the main branch just above the trunk and extended down the trunk to a point just above the ground. By means of these four antennas the tree started to make new growths within fifteen days after a storm; on the present date (the 15th of October) it has produced many new shoots and the fruit has improved noticeably, is juicy and sweet. At present on the tree are flowers and fruits of all sizes and it continues to flower and produce fruit. The tree is completely rejuvenated.

Jose Gallegos.

As the Patterson-Sargent Company says:

"The choice of mill construction has proven wholly satisfactory. We feel that for our purpose it is superior to any other type of construction."

A Room in the Plant of The Patterson-Sargent Company, Long Island City, New York, Manufacturers of B. P. S. Paints, and B. V. S. Varnishes

The Ballinger Company, Architects and Engineers

Every Manufacturer whose business demands utmost flexibility of internal plant arrangement should read this —

The Popularity of the Mill Construction Building Is Enhanced by the Ready Availability and Fine Structural Qualities of Douglas Fir

An increasing percentage of the big timbers and plank required for all general construction purposes are being supplied today in Douglas Fir from the Pacific Northwest.

From the fine structural qualities inherent in the species, scientific selection makes it possible to secure, *on special order*, where exceptionally heavy loadings demand it, a "select structural grade," the equal, if not the superior, of any structural wood on the market today.

Through the Weyerhaeuser distributing plants at Baltimore and Minnesota Transfer, Saint Paul, Douglas Fir in all standard grades and sizes can be laid down quickly and economically in every industrial section of the country.

Twenty-two percent of all the lumber produced in this country today is Douglas Fir.

Quoted by Permission from letter of

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Architects and Engineers, New York

"With reference to the Patterson-Sargent project, a marked advantage that mill construction has over masonry construction—the ease with which alterations can be made—was a matter of primary importance in the manufacture of paints and varnishes. Alterations or extensions of the plant equipment almost invariably involved changes in the rather elaborate system of pipes through which the material flows. Mill construction permits the perforation of the floors for new piping at practically any point at a small cost."

BUSINESS men who know the importance of keeping down plant overhead are paying more and more attention to the adaptabilities and *economies* of heavy timber *mill construction* for factory and warehouse expansion.

It is the business of the architect and engineer to advise you whether Mill Construction is adaptable to your individual building requirements. Or, if you prefer, there is available the consultation of a Weyerhaeuser Expert Construction Engineer.

The advantages of "Mill Construction" and the structural quality of Douglas Fir are thoroughly covered in the Weyerhaeuser booklets "Industrial Buildings" and "Structural Timbers of Douglas Fir" and in "Technical Note No. 201" issued by the U. S. Forest Products Laboratory. These booklets will be sent on request to responsible members of industrial concerns.

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Producers for industry of pattern and flask lumber, factory grades for remanufacturing, lumber for boxing and crating, structural timbers for industrial building. And each of these items in the species and type of wood best suited for the purpose.

Also producers of Idaho Red Cedar poles for telephone and electric transmission lines.

Weyerhaeuser Forest Products are distributed through the established trade channels by the Weyerhaeuser Sales Company, Spokane, Washington, with branch offices at 208 So. La Salle St., Chicago; 220 Broadway, New York; Lexington Bldg., Baltimore; and 806 Plymouth Bldg., Minneapolis; and with representatives throughout the country.

Perhaps you, too, can cut your "B" battery costs in half. Just follow the chart. It gives you the secret of "B" battery economy

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On sets of one to three tubes, Eveready "B" Battery No. 772, used with a "C" battery, will last a year or longer, usually longer. On sets of four and five tubes, either of the larger Heavy Duty Eveready Batteries No. 770 or No. 486, used with a "C" battery*, will last eight months or more.

These figures are based on the average use of receivers, which a country-wide survey has shown to be two hours daily throughout the year. If you listen longer, of course, your batteries will have a somewhat shorter life, and if you listen less, they will last just that much longer.

Here is the secret of "B" battery satisfaction and economy:

With sets of from 1 to 3 tubes, use Eveready No. 772. With sets of 4 or more tubes, use either of the Heavy Duty Batteries, No. 770, or the even longer-lived Eveready Layerbilt No. 486.

Use a "C" battery on all but single tube sets.

Eveready's give you their remarkable service to the full when they are correctly matched in capacity to the demands made upon them by your receiver. It is wasteful to buy batteries that are too small. Follow the chart.

In addition to the batteries illustrated, which fit practically all of the receivers in use, we also make a number of other types for special purposes. There is an Eveready Radio Battery for every radio use. To learn more about the entire Eveready line, write for the booklet, "Choosing and Using the Right Radio Batteries," which we will be glad to send you on request. This booklet also tells about the proper battery equipment for use with the new power tubes. There is an Eveready dealer nearby.

Manufactured and guaranteed by
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*NOTE: In addition to the increased life which an Eveready "C" Battery gives to your "B" batteries, it will add a quality of reception unobtainable without it.

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-they last longer

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WFI–*Philadelphia*	WOC–*Davenport*
WGR–*Buffalo*	WCCO {*Minneapolis* / *St. Paul*
WCAE–*Pittsburgh*	

KSD–*St. Louis*
KGO–*San Francisco, 8 P. M. Pacific Coast Time*

Radio Notes

A Review and Commentary on the Progress in This Branch of Rapid Communication

Conducted by Orrin E. Dunlap, Jr.

Wide World

A waterproof radio transmitter has been designed especially for use in lifeboats. The operator's hand and arm are covered by a canvas bag which keeps water from entering the waterproof cabinet

Is Radio Menaced by Strange Rays?

RADIO followers, who have been reading in the papers of the new scientific discovery of wild and powerful rays traveling from the "depths of outer space" toward the earth with the speed of radio, are likely to wonder what effect they will have upon broadcasting and the ether.

The extremely short length of these immigrant waves, of 10,000,000-volt variety, which is estimated to be much shorter than X-rays, is "unimaginable," says Dr. R. A. Millikan, discoverer of the rays, who has been probing and studying nature's secrets upon the edge of finite space. So powerful is their energy after they penetrate the upper regions of the atmosphere that it is estimated Old Mother Earth might experience a disastrous effect should the number of rays increase.

Dr. Millikan reports that these rays come from space and bombard the earth from all directions at all times, and that they have extraordinary penetrating power.

Will they, like the sun's rays, menace radio by absorbing its strength?

There is no doubt that the rays of Old Sol are responsible for the limited range of radio concerts in the daytime. This is proved by the fact that as soon as twilight blends into darkness the distant stations begin to come forth from loudspeakers hundreds of miles away, and as the night progresses the waves span greater distances, with increased intensity. Then come the first faint traces of dawn in the Eastern sky and the distant transmitters begin to wax and wane, suddenly vanishing, producing at sunrise a death-like silence in the radio realm.

Radio experts explain that the ultra-violet rays and other beams radiated from the sun penetrate the atmosphere and act as millions of antenna, absorbing radio energy, or serve as a pathway over which Hertzian waves reach the ground before they have an opportunity to seek an antenna. One might picture this effect of the sun's rays as a curtain made up of myriads of wires stretched from the sky to the earth, but when darkness sets in the curtain rises and the radio theatre is opened on a national scale. It is then that receivers in New York skyscrapers can be put in tune with melodies played out where the corn grows tallest.

What would man do if these immigrant waves increase in number and have an ill effect upon the ether? All radio might vanish and the great radio industry which grew "over night" would crumble. What assurance has man that the ether will always remain to vibrate with human thoughts and emotions? These strange rays might wipe radio out over night and several have suggested that man himself will destroy the ether, because with millions of receiving sets tapping the invisible, odorless, tasteless substance, it may finally be used up. Others dispell such fear and contend that the ether is an everlasting supply and will occupy all space until doomsday.

Others point out that these new rays may be signals from another planet and they add weight to this contention by calling attention to the fact that the mysterious waves are extremely short in length. This shortening of wavelengths seems to be the trend radio is following in its earthly development as amateurs talk from nation to nation, across continents and over seas, on short wavelengths propagated by less power than is required to operate an electric iron. If a boy can do this from the attic of his home, why could not some race of superior development devise a system of short wave communication far more effective and powerful than man has discovered on earth? Undoubtedly, 1,000 years hence, the earth's inhabitants will look back upon our radio of today as only a crude and tiny link in the chain of their ultra and inter-planetary broadcasting system. Perhaps these nomad rays, which are being wafted in from the infinite, are transporting motion pictures of other worlds, but we are so far behind in radio science that they cannot be flashed upon earthly screens.

Some say that there is no cause for alarm because no one seems to be sure that there is such a medium as the ether. It is an established fact that the air is not the basis of radio, so there must be another medium; and scientists have named it the ether. They tell us that the ether occupies mountains, that it exists in a vacuum, in our bodies and in the walls of our homes, and that

Wide World

Owners of receivers in Japan pay a fee amounting to about eighty cents a month to the Tokio municipal station. The sets are sealed on this one wavelength so that the operator cannot tune in another broadcaster

is why indoor antenna intercept radio broadcasts. Did you ever stop to think that, no matter where you are, housewives' talks, symphonies and jazz, sermons and news, pass through your body at the speed of sunlight, 186,000 miles a second. Whatever this peculiar medium is, it seems to be everywhere!

Charles P. Steinmetz startled the radio world shortly before he died by declaring that there were no ether waves! He argued that radio and light waves are merely properties of an alternating electro-magnetic field of force that extends through space. Steinmetz said that the conception of the ether is one of those hypotheses made in an attempt to explain a difficulty, and the more it is studied the more unreasonable and untenable it becomes.

Sir Oliver Lodge, on the other hand, is a staunch defender of the ether's existence. He believes that, because the ether is invisible is no reason for saying that it does not exist. Those who agree with him point out that man and animals breathed the air for thousands of years before the chemical constituents were known or even that the air had weight. A barometer was needed to prove that fact. If it required centuries to learn about the air, why cast aside theories regarding the ether or worry that it may be destroyed by some outside force? No instrument has been discovered to prove that the ether exists. It remains one of the mysteries of God's handiwork along with radio and the Millikan rays.

Broadcasters Using Powerful Tubes

A NEW 10-kilowatt vacuum tube, which vibrates at the rate of 5,000,000 times a second and requires for operation at full capacity as much current as would be used to light every room in a dozen six-room dwellings, is now in use at KDKA, WBZ, KFKX and KYW. The tube uses a voltage that is twenty times as high as traction companies use to propel street cars.

This tube handles so much energy that it has been impractical to build a base that would not be burned up if all the filament, grid and plate leads were run through the base. Consequently, the leads are taken off at different places—the filament wires at the bottom, the grid lead at the side and the plate wire at the top.

The tube stands a foot and a half in height. A water jacket carries off the heat created when the 15,000 watts of energy are applied to the plate.

The plate is a copper tube nine inches long and an inch and a half in diameter, closed at one end. Almost the entire length of the plate protrudes from the top of the tube. The water jacket is fastened to the plate and water is circulated under pressure to absorb the heat. The column of water is about twenty feet long. The hose is half an inch in diameter. The amount of current which leaks away to the ground through the column of water is negligible. The resistance of water to the flow of electrical current is more than a billion times that of a

Kadel & Herbert

Tuning a ship's radio aerial system. The wavelength on which the *S.S. Gripsholm* operates can be quickly changed by this unique layout of taps

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PITTSBURGH

Apollo

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APOLLO-KEYSTONE *Copper Steel* GALVANIZED SHEETS
CULVERT, FLUME AND TANK STOCK
FORMED ROOFING PRODUCTS

Black Sheets for all Purposes

AUTOMOBILE SHEETS—ELECTRICAL SHEETS
DEEP DRAWING AND STAMPING STOCK
TIN AND TERNE PLATES

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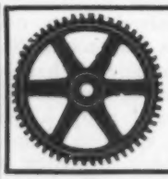

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Radio Sets on Farms Growing in Number

THERE are close to 600,000 radio receivers on farms in the United States, and the number is rapidly increasing. The farmers' appreciation of broadcasting is seen in the fact that there has been a 300 percent increase in radio sets on farms since 1923. Dealers in various parts of the country report that the farmer generally buys a high-class set, costing between $125 and $400.

Twenty-four agricultural colleges maintain broadcasting stations; and they cooperate with the Department of Agriculture in sending out weather, crop and market reports.

Tests Show February Best for Radio

OBSERVATIONS made by the Bureau of Standards on the waves of KDKA revealed the following results: The worst atmospheric conditions were experienced in June and the February air seemed to be superior to that of all other months. The next best months were in order, March, January, November, December, May, October, April, August, July and September.

The worst fading was encountered in October and the least in February, with fading increasing in the following order: April, July, March, June, January, May, November, December, August and September.

Big Radio Market in Chicago

ALTHOUGH there are approximately 686,000 homes in Chicago, it is estimated that there are only about 100,000 receiving sets in operation in that city.

When to Tune in Cuban Stations

STATION 7SR, Elia, Cuba, will be on the air at 8:30 P.M., Eastern Standard Time, every Tuesday and Thursday up to May 1st. The transmitter is rated at 500 watts and the wave is 295 meters. Station PWX, Havana, is on the air Wednesdays and Saturdays from 8:30 to 11:30 P.M., Eastern Standard Time, and can be heard on the 400 meter wave. Station 6KW, Tuinucu, broadcasts every day from 8:00 to 10:15 P.M., Eastern Standard Time. It can be found on the 338 meter wave. The transmitter is rated at 500 watts on week days, and 6,000 watts on Sunday nights.

Radio Sets' Total Nears 5,000,000

IT is estimated that there are now about 5,000,000 radio sets in operation in the United States. There are approximately 22,000,000 homes in this country so the radio market is still very large. The total for radio is small compared with the 18,000,000 automobiles; about 15,000,000 telephones and 12,000,000 phonographs.

Five Loudspeakers in One Set

A NEW receiver named the "Zeniphonic" has been introduced by the Zenith Radio Corporation of Chicago. It is a ten-tube circuit, equipped with five stages of radio frequency amplification. There is only one dial, and it tunes over a range from 80 to 600 meters. The ordinary tuning range is from 180 to 600 meters; but it is quickly lowered by throwing a small switch inside the cabinet. The purpose of this wide tuning range, according to officials of the company, is to make provision for what they believe to be an inevitable development in broadcasting, that is, the extension of the broadcasting wave band below 100 meters. Several of the models are equipped with two loudspeakers, which give a balance between the high and low tones. The most expensive model has five loudspeakers, to insure high quality of tone.

Predicts Six Companies Will Control Radio

COMMENTING upon the increase in radio sales, Alexander Eisemann, Treasurer of the Freed-Eisemann Radio Corporation, said that in his belief 95 percent of the radio business will be done by less than six companies. He pointed out that at the present time 90 percent of the automobile business is done by twelve companies.

"The larger units in the radio manufacturing business now well established will

Fotogramas

The *S.S. Gripsholm*, the electrically driven Swedish liner, has a two kilowatt spark set which carries 500 miles in daylight. At night the range is greater

Kadel & Herbert

The radio receiver on the *S.S. Gripsholm*. The circuit has a tuning range of from two hundred to three thousand meters

grow bigger, and there will undoubtedly be considerable mortality among the smaller units, just as was the case in the phonograph business years ago. It is very evident that five or six companies whose position as to product and merchandising policies is well entrenched, are growing stronger and stronger, and that within a very few years the bulk of the business will be concentrated in comparatively few hands. New capital is no longer rushing into the radio business as it formerly did," says Mr. Eisemann.

Pictorama

The new liner *Berlin* is the first ship to be equipped with radio telephone booths for the use of passengers. The booths are connected with the ship's radio room, much like a regular telephone switchboard. Passengers can talk to other ships within a few hundred miles

A Radio Puzzle for Home Builders

THE architectural and engineering bureaus of the National Lumber Manufacturers' Association declare that the general use of radio in the home has precipitated a new and perplexing problem for builders. It appears that, co-incidently with the popularity of broadcasting, a new form of exterior wall construction was widely introduced, especially in Florida, other parts of the South, California and the Southwest. In taking advantage of the mild climate in those regions, and for the purpose of reducing building costs, people have adopted skeleton-surfaced houses, eliminating shingled walls, but substituting stucco-surfaced siding. Generally, the wooden framework of the house has no lumber sheathing. Instead, metal lath or chicken wire is applied directly to the studdings, and then the stucco is plastered over the webbing. This metal network creates a shield for radio waves and prevents Hertzian impulses from reaching indoor antennas or loops, which are popular in southern climes because they are not exposed to intercept as much static as an outdoor wire.

Some lumber dealers throughout the South are taking prompt advantage of the metal lath shields and are encouraging all-lumber homes. It is pointed out that a receiving set located in a house shielded by wire or metal lath will not be shielded, providing an outdoor antenna is employed. It is the antenna that intercepts the energy from the ether, and if it is not shielded the receiver attached to it will work all right, although it may be in an all-metal compartment.

Overcoming Changes in Aerial Capacity

JOHN HAYS HAMMOND, JR., has invented a means of compensating for variations in the capacity of an antenna circuit caused by changes in the effective height of the wire. Such changes might be effected, for example, by the roll or tipping movement of a ship to which the antenna is mounted.

College Station Acts as Relay

RELIABLE and consistent radio relay of broadcast signals up to 300 miles is best obtained on long wavelengths, according to tests made between WGY and WCAD, St. Lawrence University, Canton, New York. The operators at the college station intercept the programs from Schenectady, broadcast on the 1,560 meter wave.

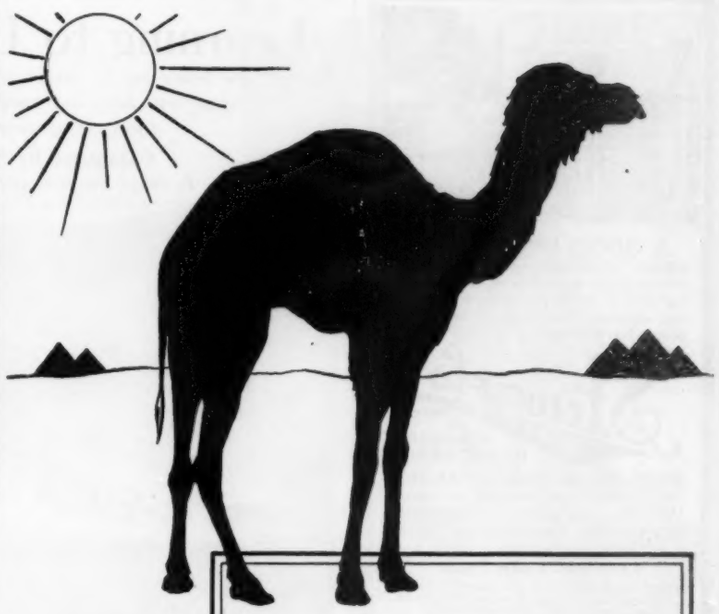
All programs of WGY are radiated on 379.5 meters, 41.88, 109, and 1,560. Observations of the transmissions on each wavelength are made. Experiments in relay-work between WGY and WCAD indicate that 1,560 meters is superior to such waves as 40 meters or 100 for relay purposes.

15,110 Amateur Stations

THERE are now 15,110 amateur transmitting stations licensed in the United States. The number has decreased since last year when the number totaled 15,450.

Miniature Station for Testing

ONE of the smallest practical broadcasting stations is in use at the King Quality Products radio plant at Buffalo, New York. It was put into service to meet an insistent demand for morning broadcasting so that sets at the factory could be tested, despite the fact that the regular broadcasters were off the air. The miniature station is mounted on a panel eight and one-half inches square, and it is attached to a phonograph. The transmitter's wavelength range is from 200 to 600 meters and can be heard in the area of a city block.



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The Bristol *Pullman*, an interesting ten-passenger airplane, equipped with a Lucifer 400-horsepower, air-cooled engine

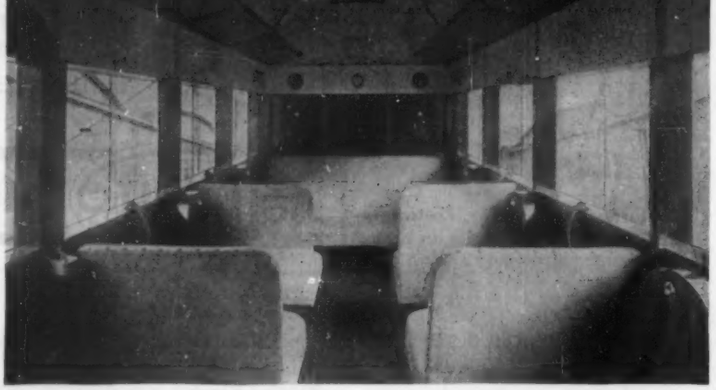
The Bristol "Pullman"

THE possibilities of multi-engined planes while great have not by any means caused the disappearance of the single-engined air transport. The simplicity of the single-engined power plant and the greater efficiency of the single-engined plane which has no inefficient head-resistance-producing-engine nacelles to pull through the air have left many adherents of this type of plane. For example, the Bristol *Pullman*, with only 400 horsepower in its single Lucifer engine, can carry ten passengers through the air at a speed some ten to twenty miles greater than the Farman *Jabiru*, or the Blériot "quadri-moteur" which with 720 horsepower can only carry 12 passengers.

The efficiency of the single-engine type is particularly marked when an air-cooled engine is employed and the weight of radiator, and water in engine and radiator are saved. In the *Pullman* the front of the fuselage is skilfully rounded off and little of the air-cooled engine is actually exposed to the blast of air. The pilot sitting high in the fuselage has a vision which is quite as good as in the four-engine jobs where there is no engine ahead; and it is undoubtedly easier to watch one engine and one set of engine instruments than it is to watch the switchboard of a multiple-unit power plant.

At the present time passenger comfort is being carefully studied by both American and foreign designers. One of the signs of this increasing care for the passengers is in the long exhaust pipe carried by the Bristol *Pullman*. This pipe is at least twenty feet in length and is carried far behind the passenger compartment. The pilot still has somewhat of a climb on the outside ladder to get into his cockpit; the passengers have to mount but three or four feet off the ground.

The photograph of the interior of the *Pullman* emphasizes the care now lavished on the passenger cabin. The passengers are seated on roomy, well-upholstered seats. Each passenger can see a clock, an altimeter and an air-speed indicator ahead of him and can tell thereby where he is, how high he is and how rapidly he is reaching his destination—not with the accuracy of the navigator, but with sufficient accuracy to satisfy natural curiosity. There are no crosswires or beams of any description in



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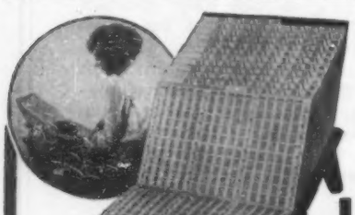
Interior of the Bristol *Pullman*. The passengers are seated on comfortable seats, the windows can be completely opened and the instruments at the end of the cabin tell the airplane's speed and height



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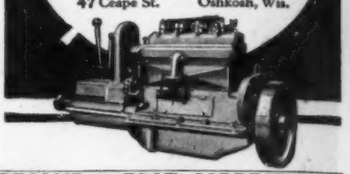

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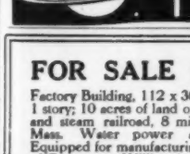

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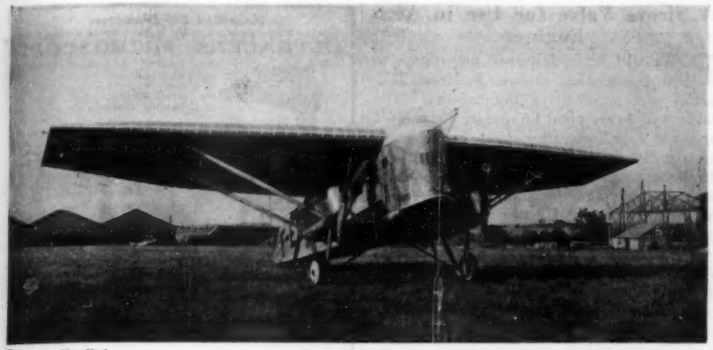

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The Farman *Jabiru*, a four-engined monoplane carrying twelve passengers, with two engines in tandem on either side of the fuselage

the cabin, and each window can be wholly opened if desired. In cold weather special arrangements for tapping the exhaust allow the cabin to be comfortably heated.

Four-Motored Airplanes

A GREAT many aircraft operators are agreed on the necessity of multi-motored airplanes in air transport to provide the greatest safeguard against power-plant failure. The British Air Ministry has encouraged the construction of a number of three-engined planes; Junkers and Fokker have each produced passenger carrying craft, equipped with three engines. French constructors have gone even further in this direction by building four-motored planes.

The basic advantages of using four engines instead of three are: 1. The greater security against power-plant failure; when one engine of the four goes out of commission the loss of power is unimportant as far as ability to continue the flight is concerned and even if two engines go out of commission, the plane should be able to reach its destination, although with some difficulty (whereas the failure of two engines on a tri-motored job means a forced landing even though the glide downwards may be very gentle). 2. The even number of engines employed allows the disposition of two engines on either side of the central fuselage, frees the passenger carrying fuselage of gasoline tanks and minimizes the danger from fire to the occupants in case of a crash.

The use of four engines involves certain special difficulties, however. The more engines employed the greater the complexity of the power-plant and instrument system. It is quite a task to keep four engines running smoothly together, and the engine instrument board requires as much careful study as the switchboard of a large power station on the ground. Also, it is difficult to arrange the four engines so as to maintain both aerodynamic and propeller efficiency.

As the photographs indicate, Farman and Blériot have arranged the engines of their respective designs in radically different ways.

The Farman *Jabiru* is equipped with four 180-horsepower Hispano-Suiza engines. The pilot and his mechanic sit at the front end of the fuselage, at its very top, so that their vision is almost perfect in all direction. Two powerful headlights in the front of the fuselage are useful for a night landing. The thick wing monoplane is free from excess of bracing and has a span of 62 feet. A speed of over 100 miles per hour is obtainable and a climb to 13,000 feet in 37 minutes. The deep fuselage provides a very comfortable cabin for 12 passengers with toilet and baggage compartment in the rear. The engines are supported on a short stub-wing fastened to the bottom of the fuselage, which has considerable lifting capacity. The engines are arranged in tandem in a very neat nacelle, with the gasoline tanks between each set of engines, so that the head resistance of the power plant is not too great. But there is real difficulty in the design of the propellers. The rear propeller works in air already disturbed by the front propeller; also, since it is in the slipstream of the front propeller, it is attacking air which is moving faster than the airplane, while its effective thrust is still acting with only the speed of the plane. Therefore, the efficiency of the rear propeller is lower than that of the front propeller (some improvement is effected by making the pitch of the rear propeller greater than the pitch of the forward propeller).

In the Blériot 115, which is also equipped with four Hispano-Suiza motors of 180 horsepower each and likewise carries 12 passengers at a speed of over 100 miles per hour, a biplane structure is adapted with each engine in an individual nacelle. The disadvantage of the tandem propeller arrangement disappears, but other difficulties present themselves. The projected area of the power-plant nacelles is now twice as great as in the Farman *Jabiru*. Another difficulty is the very high thrust of the engines, mounted on the upper wing. If, on taking off, the lower engines suddenly fail, a disastrous nosing over of the ship is almost a certainty. Even in the air the pilot must be prepared to meet sudden and powerful changes in balance conditions if one of the upper motors fail. Yet in practice, the Blériot is flying quite satisfactorily. It is being used on the Paris-Strasburg-Warsaw and on the Paris-Strasburg-Vienna-Constantinople airlines..

In all probability, the ultimate solution of the multi-engine problem will be the provision of several motors in a central fuselage, working on one propeller, but provided with clutches so that any motor can be thrown out of the system at will. Minimum head resistance and ability of the mechanic to overhaul any unit that is out of commission are powerful incentives to experimenters.

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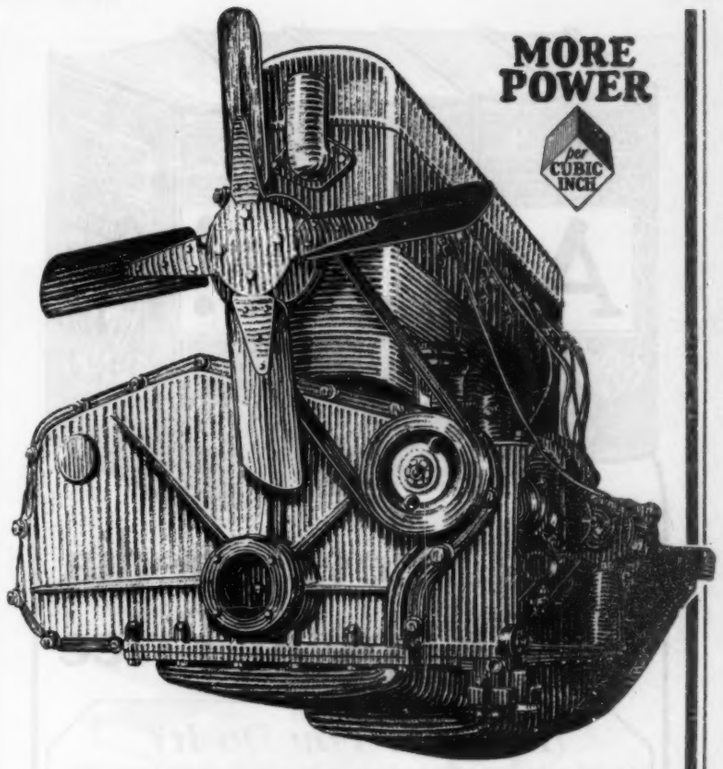
The Blériot 115, which illustrates another system of disposing of the engines in a four-motored plane



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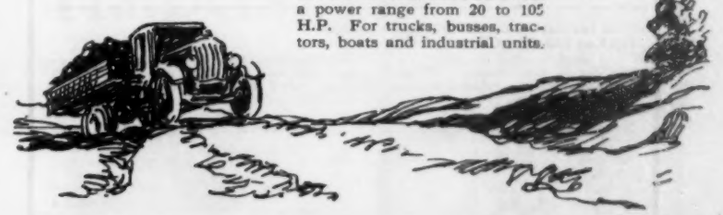

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In the second place, the binding is not of the costly kind, though, like the paper, it serves its purpose. Being of cloth, it will stand wear, as many forms of more expensive binding will not. Nothing is spent on the binding for pretense or show. It has the good looks of honesty and usefulness.

In the third place, the mechanical cost of printing and binding and distribution has been reduced by quantity production. We all know that the cost of the Ford car has been reduced by the same means. What business men call the "overhead" is divided up into so many fragments by the number of volumes that each volume bears a very small share of it.

Now it is to this overhead that is charged a great part of the cost of collecting the information and putting it into a concise, clear, and interesting form. And this is where all the money was spent that needed to be spent to make this extraordinary encyclopedia what it is. Saving there by scrimping was not necessary. And so owners of this encyclopedia have in a convenient form a body of information, conveniently arranged, so abundant that I am surprised it can be put into such space. I do not know where an equal amount of general information can be found in the same compass. I certainly do not think it can be found anywhere at such a price.

All human work is fallible. I suppose there are errors in this. But the high standing of the men who are responsible for the editing of it is warrant for the high quality of the scholarship that is represented in it. The information is modern, covering events as late as 1924, presented with extraordinary impartiality, based upon recent facts and conclusions of science, history, and other departments of human knowledge. Hereafter I shall have it at hand, and in most cases it will be the first encyclopedia to which I shall turn.

I should like to tell you more about the encyclopedia itself. It is a sort of Who's Who of living celebrities as well as of the distinguished of all times. Its more important articles are well worth reading for their own sake as well as for the purpose of reference. I do not know, for example, where else one can find such a survey of the World War; or such an account of the automobile, with not only such a story of its past and such a description of its essential parts, but such a peering into its future; or such bird's-eye views of recent events like the rise of the Irish Free State.

If I could send a gift to every household with which I am acquainted, I think I should choose this set of five volumes of the New Universities Encyclopedia. No matter what other encyclopedias one may own, there will be a use for this to which no other could be put. For the student in school or college it affords quick access to the main facts of any subject he would like to look up. For anyone whose time is limited this encyclopedia is particularly welcome, because it does not require search through long articles for outstanding facts.

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A Sleeve Valve for Use in Aero Engines

POWER-PLANT failures, according to British statistics, account for from 21½ to 50 percent of flying unreliability. The sources of power-plant failure are themselves analyzed as follows: 28 percent in the water system; 19 percent due to valve breakage; 10 percent in the oil circulation system, with the remaining 43 percent accounted for by actual breakage of materials in the crankcase, housings, and so on.

The readiest way to get rid of water-system troubles is to use air-cooled engines. To meet the valve problem, the British are resorting to a well-known automobile device and building a sleeve-valve aero engine similar in principle to that employed in the Willys-Knight automobile.

Safety in Air Transport

IN a presidential address before the Royal Aeronautical Society, Major General Sir Sefton Brancker reviews six years' experience of British air transport, now concentrated in one company, the richly subsidized Imperial Airways.

Sir Sefton summarizes the sources of dangers as follows: a, breakage of the aircraft itself in the air; b, jamming or failure of the controls; c, fire; d, engine or installation failure over heavy sea or country where a safe landing is difficult or impossible; e, error of judgment or sickness on the part of the pilot, and g, collision either in the air or on the ground.

This list of possible dangers looks formidable, yet actually, the number of fatal accidents in British air transport since its inception is only five, and, for every source of danger, a safeguard or a line of investigation leading to a safeguard is readily available.

Modern airplanes seldom break in the air and there is practically no air strain which they cannot meet, if up to designed strength. With wooden airplanes, however, the possibility of deterioration and of resulting weakness in some vital part is always present. Therefore, the development of metal construction for every part of the airplane is advocated.

There is no excuse for the failure or jamming of the controls. Correct mechanical design and careful inspection should eliminate this entirely.

As regards possibility of fire, General Brancker is optimistic: "I think that it is fair to say that in a well tried-out machine, properly looked after, the danger of fire in the air is negligible. The danger involved by the remote possibility of a gasoline pipe breaking is guarded against by the provision of fireproof bulkheads between the engine and the crew and cabin. . . . The danger of fire in case of a crash is admitted, but can be reduced to the minimum by the careful placing of tanks and the avoidance of pressure systems of gasoline feed."

To guard against the dangers of engine failure over unpromising territory, the General gives the following advice to engineers and designers: They must devise and install an infallible power plant even at the cost of extra weight and extra expense.

The British seem to speak rather loosely of error of judgment by the pilot. If a plane crashes, following a power plant failure or bad weather, the cause of the accident may be given as "error of judgment!" Almost no weather is too bad to fly in. High winds which have stopped the crossing of the Channel steamers between Dover and Calais have not prevented the flight of airplanes between London and Paris. But there is a strain on the pilot in such conditions, which may lead to mistakes and "errors of judgment." The remedy lies in the design of airplanes of greater stability and easier maneuverability.

Collision may mean collision on the ground or collision in the air. The air seems to be vast enough for innumerable aircraft to fly without ever meeting, yet collisions have occurred in foggy weather at busy airdromes. The suggested remedy is, "the evolution of some form of automatic fog signal."

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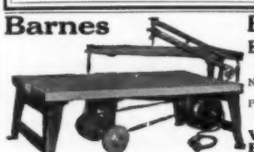

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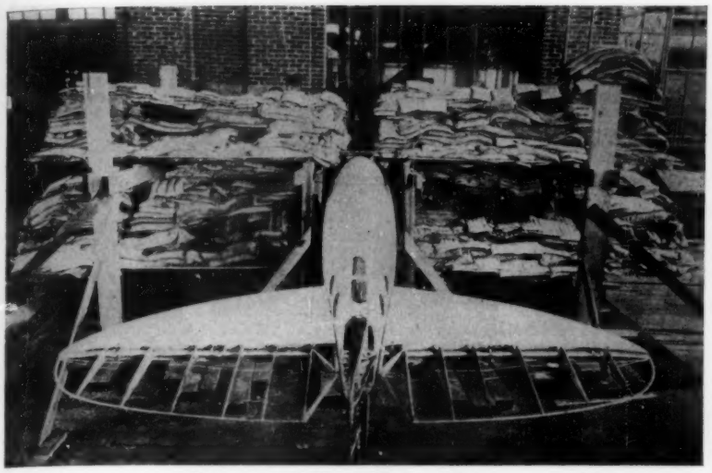


Static test of the 1925 Curtis Racer

Destroying for Safety

IN the design of airplanes, refined methods of strength calculation are employed—perhaps more refined than in any other branch of engineering. In the design of a bridge uncertainty as to strength calculations is met by adding more metal to the girders and no very great harm is done. The airplane has to meet far more rigid requirements as to weight. The simple expedient of piling on steel is not permissible. Hence, for airplanes of a novel type, particularly for pursuit airplanes in which the pilot can by skilful and violent maneuvering impose great strains on his craft, reliance is not placed entirely on the engineer's calculations.

Static testing or sand testing to destruction is resorted to. Our photograph shows the static test of the wings of the 1925 Curtiss racer. It will be noted that the wings are upside down in the test. In the air the forces on the wings act *upwards*. The sand bags or lead-shot bags can only exercise forces downwards under gravity—hence, if flying conditions are to be simulated, the wings must be upside down.

In a sand test the distribution of the bags on the wings simulate air pressure as far as possible. The bags are carefully arranged on the floor to represent so many loads. As each unit load, representing approximately the gross weight of the airplane, is applied, the wings are slowly released from supporting jacks and deflections at various important points are carefully measured. The jacks also prevent the complete collapse of the wings when a failure does occur, so that the observers can see the exact character and extent of the failure. By such methods extraordinary advance has been made in securing large factors of safety for airplane structures.

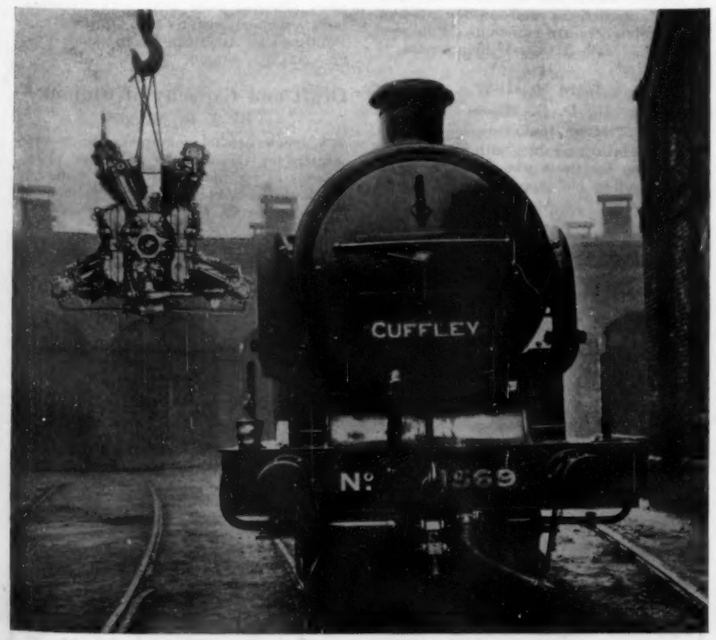
During the war single-seater pursuit ships were constantly flown with factors of safety of only five or six. Now machines with factors of safety of fifteen are being built, yet with structures so light that the highest performance in speed and climb is nevertheless obtained.

A Contrast

ENGLISH locomotives appear ridiculously small to American eyes, efficient though they are. Still they form a striking contrast in size with aero engines of equal power. Witness the *Cuffley*, an express locomotive of 1,000 horsepower and weighing 318,000 pounds, and the Napier Cub Aero engine, which with its four banks of four cylinders, delivers 1,000 horsepower likewise, but weighs only 2,300 pounds.

Lessons of the World Flight

THE "First World Flight" (written by Lowell Thomas, published by the Houghton Mifflin Company of Boston) makes fascinating reading. Lowell Thomas is a well-known explorer and he has made a splendid story of "the personal narratives of Lowell Smith, Erik Nelson, Leigh Wade, Leslie Arnold, Henry Ogden, and John Harding," the six young Army Air Service



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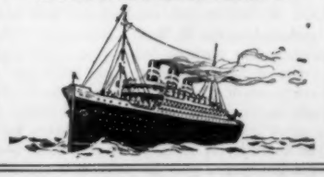

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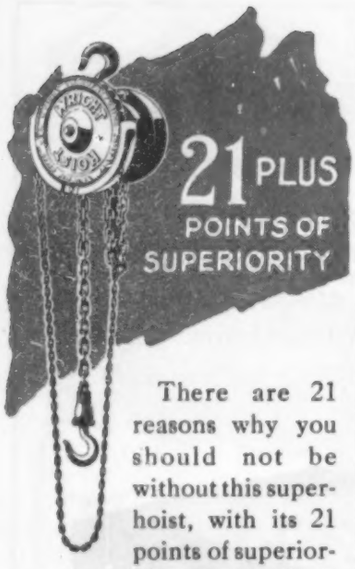

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lieutenants whom he accompanied in a friendly plane for thousands of miles. At the time that these dashing young aviators were circumnavigating the globe, we thought our interest had been killed forever by an abundance of front-page news stories. But now, nearly eighteen months after the glorious feat, we read this book with full interest. Besides the personal interest and the sense of adventure the book leads to certain conclusions which bear on the development of world air transport.

It is true that the world flight occupied 172 days, and that the fliers had the most thoroughgoing and skilful support of their own government and of the governments of twenty-two other countries. Nevertheless, the fact remains that with proper preparation a plane can fly in every part of the globe and in every kind of weather. As well as good planes and good pilots, air transport needs meteorology, and more meteorology. It was only by months of expert study of winds and other weather conditions that the flight was made possible.

Planes must be supported by the most careful ground organization. An instance of this is in the wonderful arrangements made by the Air Service in providing all over the globe boxes containing spare parts for planes and engines, small quantities of standard utility parts, material such as tubing, shock absorber cord, plywood and so on, with the boxes themselves constructed of ash, spruce and plywood to serve for possible repairs.

The instinctive flier who relies only on his skill and sense of balance must yield to the ultra-scientific pilot who can handle the following formidable collection of instruments: the tachometer, the air-speed indicator, the ampère-meter, the volt-meter, oil-pressure gauge, gasoline-pressure gauge, altimeter, an ordinary airplane compass, an earth-inductor compass, a bank-and-turn indicator, comprising two small gyroscopes for flying in fog, six gasoline-control valves, altitude controls, to change the proportions of gasoline and air fed to the engine at varying heights, and an engine primer for starting in cold weather—and this is not the complete list of instruments carried by these practical men.

The physical well-being of a pilot is as important as his training in flying and navigation. Before the long journey, both pilots and mechanics devoted several hours a day each to calisthenics, medicine-ball, tennis, basketball and road work, as though they belonged to a football squad!

The importance of detail in the power plant is forcibly illustrated by the mishap occurring to Leigh Wade in the early stages of the trip when, because a drain-cock had vibrated and broken loose, he was forced to make a bad landing near the Sacramento River.

The effect of tropical heat on the air and the consequent inability of a plane to get aloft when fully loaded, the effect of intense heat on fabric-covered wings, the difficulties of fog flying, the dangerous effects of the wash of the propeller on a following plane, the hazards of mooring seaplanes in unsheltered seas, are a few of the technical points which the journey brought to light or emphasized.

An interesting book of adventure is thus, as well as a source of useful information on the general art of aviation.

Landing at Night

LANDING safely on an airdrome at night is quite a difficult problem. The earliest method employed was to place a battery of searchlights about the field, directing the rays upon the ground. But this method was found to be both expensive and inefficient.

After much experimentation a single floodlight of 500,000,000 candlepower has been developed by the B. B. T. Corporation which answers the purpose far better. The light carries a large ground lens, built up of twenty-one dioptric elements, and throws the light in an arc of 180 degrees, covering an area of approximately half a square mile. The intensity is such, however, that a book or a newspaper may be read at a consider-

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[All the above books are obtainable from the Scientific American Book Department, 233 Broadway, N. Y. C.]

The landing light on its movable chassis

able distance from the light. The direction of the rays is also very easily controllable, and the beam may be made to reflect not more than four feet off the ground, so that there is no danger of blinding the pilot.

The first of our photographs shows the landing light on its movable chassis. The second photograph shows it at work; the pilot's eye is clearly seen to be above the powerful beams, while he can evidently see the ground with perfect clearness.

The Future of Flying

LONDON *Airways* prints an interview with Professor A. M. Low entitled, "The Future of Flying." Professor Low is an inventor of distinction, a man of vivid yet scientific imagination. We read of his glimpses into the future with interest and respect.

Present-day air travel with the passenger locked up in a close and cramped cabin is far from comfortable. The worst discomfort of all and the chief cause of airsickness is the noise of the engine. Professor Low is of the definite opinion that aero engines of the future will be noiseless, with carefully designed silencers and with the large valve clearances of today cut down considerably, to lessen the chatter of the valves.

Nor have we reached the limit of speed in air travel; certainly not on the score of human endurance. "If you put a man into a closed box and send him through the air in a straight line at 400 miles per hour, how is he to know at what speed he is traveling or to feel any ill effects?"

Professor Low predicts the displacement of the wooden airplane by all-metal construction, and of the gasoline engine by a far safer engine, one burning a heavy fuel oil. In these views many authorities agree with him. But perhaps some of these authorities will be startled by the statement that "eventually all aircraft may be driven by power, broadcast into the air from wireless stations." Here is a still more extraordinary prediction: "There is no reason why, with metal aircraft they should not be made to land or ascend in an electromagnetic field."

The Professor has very strong views about airdromes. "Airdromes at present are one of the greatest handicaps to the development of flying. Streets will eventually be roofed in to provide landing grounds for aircraft. . . . The airport of the future will be a very different thing from the temporary, lonely and muddy thing it is at present. A hundred years hence, or less, the air traveler will walk into a comfortable and well appointed waiting room in the center of the city. An elevator will take him up to the roof where he will step direct into a roomy and really comfortable airplane cabin. There will be no bumping over a hilly airdrome, but the machine, mounted on a turntable, will be shot off into the air by catapaults and travel through space at over 300 miles an hour."

These fascinating opinions are encouraging to read. And perhaps what appears startling today, may soon be a commonplace.

Night Advertising

THE electric signs of Broadway may soon have an aerial competitor. Ronald Rohlfs, the well-known pilot who once held the world's altitude record, describes in *Aviation* a new form of night airplane advertising sign which seems promising.

Glass tubes of five-eighths of an inch in diameter, shaped to form any desired letters are attached to the underside of the lower wing of a biplane by special shock absorbers of very light construction. The tubes are filled with Neon gas, and, when a current of electricity is passed through them they give off a singularly penetrating red light. No reflectors are required; it is only neces-

(*Continued on page 213*)

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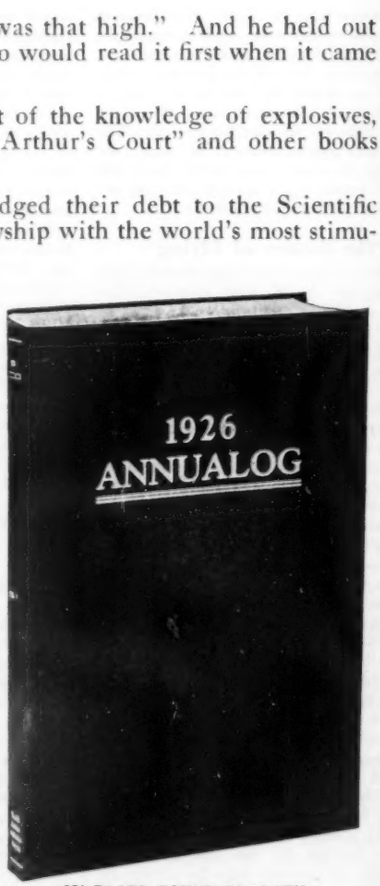

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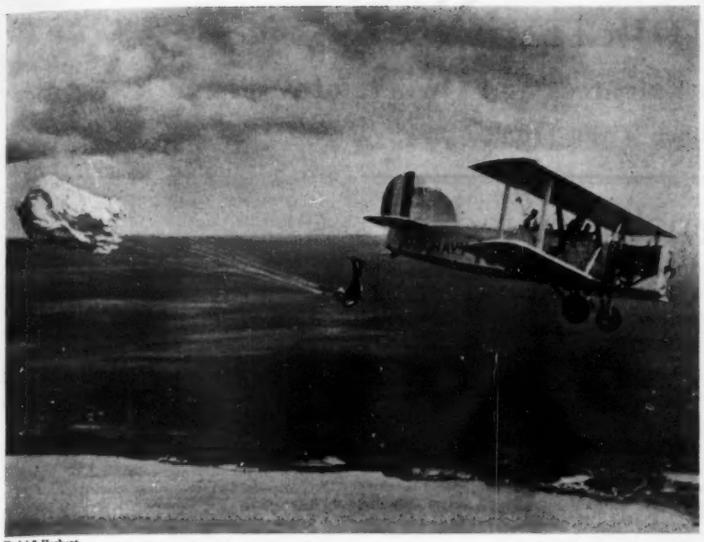

Kadel & Herbert

A "take off" by a parachute jumper, 1,500 feet above Pearl Harbor, Hawaii. The jumper is Lieut. J. R. Tate, U. S. N. The camera snapped him just as he was dragged from the speeding plane into space. His parachute has just started to open up

sary to paint the under surface of the lower wing a dark non-reflecting color.

Owing to the tubular character of the letters their air resistance is small and the unbroken line of light in each tube adds greatly to its legibility. The current is obtained from an electrically driven generator, with a step-up transformer to give the high voltage required. The whole outfit with several letters, weighs only 100 pounds and several night demonstrations of this new form of advertising have been highly successful.

Thermostatic Airship Control

IF expensive Helium gas is to be used in airships, valving losses must be reduced to a minimum. Two Berlin chemists, Drs. Kurt Peters and Peter Schlumgohm, have attacked this problem from a new angle, by providing for the control of the gas temperature. At the beginning of a voyage the gas is heated electrically so that its bouyancy is increased and the carrying capacity of the airship is thereby improved. As the fuel is burned up and the load becomes lighter, the temperature of the gas is allowed to decrease and equilibrium is thus maintained. This is perhaps a simpler method than the process of exhaust-gas recovery practiced on the *Shenandoah* and the *Los Angeles*.

Thermal control, skilfully employed might also be used to prevent valving of gas under such circumstances as heating of the gas by the sun's rays.

The Berlin chemists have not carried their work beyond the laboratory stage, but there seems no reason why their method should not be extended to use on actual airships.

Landing in a Fog

FLYING in a fog is bad enough, but radio direction finders can help the pilot effectively on his journey. But how can he land? This is how the British propose to tackle the problem this winter, according to General Brancker.

"At Croydon, during the coming winter, I hope that we shall be able to try out at full scale a complete system of landing in a fog. The aircraft will be led up to the airdrome through its wing coils. It will discover the right line of approach and alighting by balancing the signals from a leader cable (the leader cable being a cable laid along the ground and carrying a current from which aircraft can be guided by their pilots so as to fly directly over the cable); and a line of Neon lights (glass tubes filled with Neon gas which under high voltage give a very penetrating red light) laid along the leader cable on the ground will show the pilot where to flatten out as he glides down in accordance with the leader cable indications. . . . It behooves every expert in sound, light and electricity to turn his mind to this difficult and interesting problem."

Transatlantic

The Kowno Airdrome (Russia) one of the relay ports of the German-Russian-Air-Company. The number of passengers using airplanes for trips to the eastern countries is augmenting every day, the journey by plane being much shorter and much more comfortable than by train

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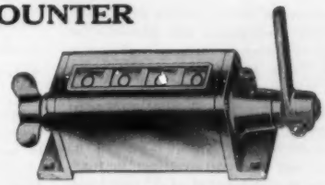

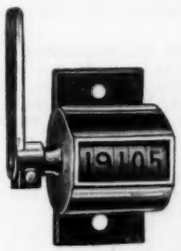

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Commercial Property News

A Department of Facts and Notes of Interest to Patentees and Owners of Trademark Rights

Conducted by Milton Wright

Better Protection Abroad

"THERE was held at The Hague from October 8 to November 6, 1925, a conference to consider the revision of the Convention of the Union for the Protection of Industrial Property," reports Patent Commissioner Robertson, who attended the conference as Chairman of the American Delegation.

"The convention, which relates principally to patents and trade-marks and provides for the granting of certain reciprocal rights, was adopted at Paris in 1883 and revised at Brussels in 1900 and at Washington in 1911. Its fundamental principle is the agreement of each country to treat the citizens of all the other countries of the Union exactly as it treats its own citizens in these matters. The Union is now composed of 32 countries, and the revised convention adopted at The Hague was signed by delegates from all these countries.

"The particular changes made relate to the working of patents, the granting of a period of years for the payment of taxes, the prevention of piracy of trade-marks and the repression of unfair competition."

An agreement was reached that the period of three years which must be allowed before any penalty can be imposed for not working is to be reckoned from the date of the grant of the patent instead of the filing of the application. This is described as a very material advantage to Americans.

Another new development is the provision for the cancellation of fraudulently registered trade-marks. This is believed to furnish an effective remedy against piracy of well-known marks.

"While the conference did not go as far in the matter of working patents and the taxes thereon as the United States delegates desired and proposed," Commissioner Robertson concludes, "it afforded very material relief from the former onerous conditions, and the adoption of the present conference is a long step forward in the direction of doing away entirely with requirements of working in order to maintain a patent in force."

Historians Take Notice

DR. IRVING LANGMUIR, Assistant Director of the General Electric Research Laboratory, is now definitely accorded a place among the world's great inventors. He has been awarded a patent for the modern vacuum tube used extensively in radio, X ray and similar work. This award ends a twelve-year battle for the patent rights.

Dr. Langmuir made his invention in 1912. Since then it has been the center of controversy. The legal battle was suspended during the World War, because of the necessity of war work being done by the litigants, but was resumed soon after the Armistice.

The tube is characterized by its hard, constant vacuum and its general reliability, permitting operation with more than 50,000 volts as well as smaller currents, such as are used in home radio receiving sets. The invention is described as making possible the enormous development of practical radio within the last ten years. It is estimated that there are more than 10,000,000 tubes embodying the invention now in operation in the United States.

Joint Inventors

FOR a long time it has been a well-established principle of patent law that where two men, who believe themselves joint inventors file a patent application jointly, later learn that only one of them actually is the inventor, they may amend their application for a patent so that the patent issues only to the one who is the inventor.

Patent Commissioner Robertson, however, in his recent decision in Ex-Parte Benes gives definite expression of the fact that the contrary does not hold true. Benes sought to change a sole patent application to a joint application, saying that his friend, Warren J. Fretz, was a joint inventor.

"It is true," says the Commissioner, "that the subject matter of the application remains the same, but it adds an additional party who did not sign the specification or join in the oath as originally filed. To accept the amendment, would, in effect, be giving a filing date and a serial number to an incomplete application, as the proposed joint application was not complete as a joint application at the time this application was given a filing date."

This rule might well have the effect of preventing a patent from ever being granted in the case of an inventor who files a sole application and later discovers that the invention is a joint one.

Victory for Small Grocers

THE independent grocers have won a skirmish in their fight with the chain store organizations. It is over the prices they pay for Uneeda Biscuit, Nabisco, Zu Zu and three hundred other products of the National Biscuit Company and Tak-hom-a biscuit, Parfetto, Yum Yum and other products of the Loose-Wiles Company.

In many localities, the Federal Trade Commission finds, there is such a demand for these advertised cakes and crackers, that it is impossible for a grocer to conduct his business without them. The chain stores, however, are able to undersell him because the big baking companies charge them less than they charge the independent man, despite the fact that each chain store, or unit, is solicited separately by a salesman and its requirements supplied just as though it were an independent store.

The independents, organized into grocery associations, demanded the same discounts for quantity purchases as the chain stores were getting. The National and the Loose-Wiles companies refused, except on the Pacific Coast, where other cracker manufacturers are outselling the National and the Loose-Wiles.

After a thorough hearing of the facts the Federal Trade Commission orders the baking companies to desist "from discriminating in price between purchasers operating separate units or retail grocery stores of chain systems and purchasers operating independent retail grocery stores of similar kind and character purchasing similar quantities of respondent's products."

Orange Beverage, 5c a Glass

YOU might visit Washington and fail to see the White House, the Washington Monument or the Patent Office, but to fail to see an "orange beverage" store would be an impossibility. The pioneer in this business is Carroll Dikeman who has a chain of retail stores throughout the city. Each has a white painted front with glass folding doors and on either side of the entrance the legend "Dikeman's Delicious Orange Beverage 5c" in gilt letters, surmounted by a representation of a cluster of oranges and foliage. The entire sign is convex and surrounded by a blue border.

Some time ago Kissel and Kokalis, Washington lunchroom proprietors, started in the orange drink business, placing at the door signs so closely resembling Dikeman's that even President Coolidge himself might be misled.

The Federal Trade Commission, however, has come to the rescue. It has ordered the lunchroom partners to stop making their place resemble Dikeman's.

Patents Recently Issued

Classified Advertising

Advertisements in this section listed under proper classifications, rate 25c per word each insertion; minimum number of words per insertion 24, maximum 60. Payments must accompany each insertion.

Official copies of any patents listed in this section at 15c each; state patent number to insure receipt of desired patent copy.

Pertaining to Aeronautics

MOORING DEVICE FOR LIGHTER-THAN-AIR CRAFT.—By means of which the ship may be safely moored by the crew, without employing operators on the ground. Patent 1551655. O. Geisler, 6947 Peoria St., Chicago, Ill.

SAFEGUARDING AGAINST AERIAL ATTACKS.—By releasing at intervals, from high speed aircraft, a series of parachutes, each supporting by a long light cable a contact bomb, to obstruct the probable line of attack. Patent 1558713. J. A. Steinmetz, c/o Jenney-Steinmetz Co., Philadelphia, Pa.

AIRPLANE-ADJUSTING DEVICE.—Wherein means are employed within the fuselage and within easy reach of the operator whereby the wings may be simultaneously shifted. Patent 1560341. H. H. Flath, R. D. No. 3, Erie, Pa.

Pertaining to Apparel

UNDERGARMENT.—Composed mainly of visca or artificial silk, and having the edges bound with real silk to prevent damage when the fabric is wet. Patent 1554860. A. Leopold, c/o Carl Gutman & Co., 334 Fourth Ave., New York, N. Y.

UNDERHOSE.—The toe, sole and heel portions being less thickness than the rest of the hose, so that they may be comfortably worn under silk outer hose. Patent 1555752. O. Osborne, Jr., 1845 E. Willard St., Philadelphia, Pa.

COLLAR SUPPORTER.—For turnover collars of the semi-soft type which functions to hold the outer portions properly spaced from the neckband. Patent 1556517. S. L. Gedney, 33 Clinton Ave., Maplewood, N. J.

UNION SUIT.—Wherein the crotch seam and belt effect are entirely eliminated, the entire construction being for comfort and freedom. Patent 1559845. J. P. Brown, 91½ Grant St., Atlanta, Ga.

NECKTIE HOLDER.—Whereby a previously knotted necktie can be readily attached to a collar button and drawn up under the collar folds. Patent 1559823. A. W. Wilson, 180 Dubocе Ave., San Francisco, Calif.

Chemical Processes

TEST FOR PETROLEUM.—For determining the flashing and burning points of petroleum products by a thermometer test. Patent 1554993. C. Ettele, c/o Standard Oil Co. of N. Y., Sannomiya P. O. Box 357, Kobe, Japan.

PROCESS OF MAKING OXYGEN, CONTAINING SOAP POWDER.—Which consists in mixing potassium-permanganate with paste-like soap, and mixing the same with an oxidizing agent. Patent 1555588. R. Korselt, Zittau, Saxony, Germany.

METHOD OF PURIFYING HYDROCARBONS.—Resulting from the distillation of crude oil containing wax, by causing crystallization and then mechanically separating the oil from the wax crystals. Patent 1562425. A. Greenspan, c/o Dr. O. Wasser, Livow, Kosciuszki 6, Poland.

Electrical Devices

BATTERY.—Constructed to carry a substitute for the usual hard rubber insulator plates, which will take up no additional space. Patent 1557952. W. L. Whidden and L. McCartney, Morgan Hill, Calif.

THERMOSTATIC SWITCH.—In which a flexible device supports a circuit breaker caused to open or close at an expansion or contraction of its support. Patent 1561425. H. R. Fernandez, 14 Villegas St., Havana, Cuba.

CLOCK MECHANISM.—In which the movement is actuated by electric impulses consisting of a minimum number of parts. Patent 1561786. H. M. Huemann, 411 6th St., Wallace, Idaho.

FOLDING-LOOP ANTENNA.—Which may be folded up and quickly extended, the wires being held normally taut when extended. Patent 1559193. M. W. Stavrum, R. L. Olson, and W. H. Berry, c/o Radio Appliance Laboratory, 4884 N. Clark St., Chicago, Ill.

Of Interest to Farmers

CHECKING IMPLEMENT.—For the throwing up of checks or levees in preparing agricultural land for irrigation. Patent 1557035. W. Dost, Route 3, Box 41, Yuba City, Calif.

APPARATUS FOR GRINDING FODDER, STRAW OR SIMILAR ROUGH FOOD FOR STOCK.—Which may be mounted upon the chassis of a motor vehicle and driven by the propelling power. Patent 1558394. J. N. Rice, 613½ So. 7th St., St. Joseph, Mo.

FRUIT-GATHERING APPARATUS.—Which will automatically pick up fruit such as prunes, or other spheroidal bodies, and deposit the same in boxes without injury. Patent 1558924. A. N. Riggs, 297 Reed St., San Jose, Calif.

Of General Interest

DRAWER ATTACHMENT FOR SINKS.—Whereby, with relatively simple means, a plurality of drawers for holding kitchen ware may be attached to a sink. Patent 1558274. C. A. Peterson, 7716 Calumet Ave., Chicago, Ill.

DAYLIGHT DEVELOPING OF PHOTOGRAPHIC PLATES AND FILMS.—Whereby the developing process can be readily carried out in the field without the use of a stationary dark room. Patent 1563228. C. D. Rodriguez, Leon, Nicaragua, Central America.

COMBINED SPACING AND TIE BAR FOR CONCRETE FORMS.—Particularly adapted for use in connection with the usual wooden forms employed when building concrete foundations, walls and the like. Patent 1556313. J. H. Dodd, P. O. Box 703, San Francisco, Calif.

CARD-INDEX FILE.—In which the cards are arranged radially above a drum in a manner to be readily accessible. Patent 1558376. L. R. Lewis and J. J. Colvin, Hudson Falls, N. Y.

GUTTER MOUNT.—Which permits the gutter to be removably connected to its support, and the support located under the tiles or shingles forming the roof. Patent 1558385. C. Meunier, Box 145, Great Neck, N. Y.

GRASS SEED CONTAINER.—For use in the first instance, as a sales package, and secondly as a means for sowing the seed. Patent 1558396. R. L. Roehrs, Roehrs Nursery, Rutherford, N. J.

ADJUSTABLE FINGER RING.—In which the head and shank are constructed as separate elements, adjustable to fit fingers of various sizes. Patent 1558418. F. B. Wendel, c/o Hercules Novelty Mfg. Co., 126 South St., Newark, N. J.

PROCESS FOR SEPARATING CALCINED COLEMANITE FROM CLAY AND OTHER IMPURITIES.—Consisting in discharging the material to be treated peripherally, by centrifugal force to cause a rain of particles over a circular zone. Patent 1556110. H. D. Hillmers, c/o West End Chemical Co., Oakland, Calif.

APERTURE SIGHT.—Constructed to obviate eye-strain when using cup peep sights, the device may be readily fitted to existing types of rifles. Patent 1558367. R. K. Johnston, 40 Dowling St., Dunedin, New Zealand.

STAGING BRACKET.—Which eliminates the necessity of employing expensive scaffolding for effecting repairs to a gutter or edge of a roof. Patent 1558425. O. Yetter, 27 Marcella St., Boston, 19, Mass.

LAWN SPRINKLER.—Whereby the sprinkler will act automatically and periodically to vary the position of the spray nozzles. Patent 1558355. C. W. Hart, 3231 Post St., Los Angeles, Calif.

RACK FOR COLLARS AND NECKTIES.—Whereby such articles may be better displayed in stores, or more selectively assembled in the home. Patent 1557989. A. Dombrowsky, Box 57, Balboa, Canal Zone.

CHECK-BOOK BLOTTER.—Adapted to be readily secured to the holder of a check book and to overlie the uppermost check. Patent 1558354. O. H. Halverson, 701 Marshall St., Manitowoc, Wis.

BINDER FOR CARDS AND THE LIKE.—Wherein the titles, names or the like appearing in the marginal portions are visible as an index. Patent 1556908. C. A. Briggs, Chino, Calif.

SHELF CABINET.—Which will do away with waste space and provide for extending shelves for the storage of maps or plans. Patent 1556711. Z. P. Pietrzycki, Klamath Falls, Ore.

BOAT.—Of the paddle wheel type, wherein the paddles dip into and out of the water in the manner of the oars of a row boat. Patent 1557990. F. D. Doty, Box 1608, New Orleans, La.

HOLDING DEVICE FOR VIBRATORS.—In which a razor with a straight edge may be clamped in either right or left hand position. Patent 1558327. G. Adelmo, c/o J. Mignone, Spring Valley, Ill.

TOOTHBRUSH.—Having a handle so formed that a roll or wad of cotton may be carried therein, for polishing the teeth and gums. Patent 1559519. T. A. Buckley, 80 Carlyle Ave., Yonkers, N. Y.

EYEGLASSES OR SPECTACLES.—With means for properly positioning the glasses and holding them always at the same angle to the eyes. Patent 1558744. E. B. Miner, 65 E. Holland St., Portland, Ore.

PAPERHANGERS' TRIMMING GAUGE.—By means of which the operator may lay a straight edge at an exact pre-determined distance from the edge of the paper. Patent 1558678. R. F. Koenig, 106 E. Washington St., Jackson, Mich.

SANITARY CAN AND SEAL.—In which coacting folding portions, not only act as a seam structure but as means for containing sealing material. Patent 1559096. W. M. Hall, c/o Flagg, Hall & Adams, 183 Main St., Brockton, Mass.

ATTACHMENT FOR CRIBS, PERAMBULATORS, AND THE LIKE.—Which will hold a mosquito canopy, or the like in proper position, and is easily removable when not desired. Patent 1559352. V. P. Nelson, 264 Lexington Ave., New York, N. Y.

CANDLE RING.—An efficient attachment for a candle whereby the same may be firmly held in any type of socket. Patent 1559304. E. L. Bearse, Centerville, Mass.

WASHING BRUSH.—Wherein the water is applied simultaneously with the application of the bristles to the surface to be washed. Patent 1559441. W. Kundel, P. O. Box 226, Hoboken, N. J.

HAIR-TRIMMING GUIDE.—Particularly designed as a means for facilitating the trimming of bobbed hair. Patent 1559363. Jean Parziale, 110-10 Jamaica Ave., Richmond Hill, N. Y.

CHART HOLDER AND FINDER.—For facilitating the tabulation of column indicia, whereby reading and comparisons may be rapidly made. Patent 1559459. J. Rogers, 32 North Ave., New Rochelle, N. Y.

SOUND BOX AND TONE ARM.—Having a mounting whereby the arm is maintained in a steady position, and more effectively supports the free end. Patent 1559514. J. Zitzerman, 449 Stone Ave., Brooklyn, N. Y.

SMOKE-PRINTING DEVICE.—Wherein smoke may be directed through a perforated member for producing a picture, or other desired configuration. Patent 1559345. P. J. Moloney, 2211 82d St., Brooklyn, N. Y.

PIPE CLEANER.—An assemblage adapted for cleaning the stem of a smoking pipe or loosening the tobacco. Patent 1558652. E. A. Thornton, Valentine, Neb.

TREE STAND.—For holding Christmas trees and the like, which may be quickly mounted, and easily stored in a minimum space between periods of use. Patent 1559563. G. Edmister, 210 South 11th St., Lincoln, Neb.

CASEMENT WINDOW.—Especially of the inswinging type, having a special weather strip for preventing wind or rain from passing between the sill and sash. Patent 1558954. A. E. Walker, 2372 Sandy Blvd., Portland, Oregon.

HOLDER.—For carrying articles relating to the use of a telephone, including the telephone book, a writing pad, pencil and a calendar. Patent 1560493. P. Steinberg, 2221 Jerome St., Toledo, Ohio.

DEVICE FOR CLEANING FLOOR DRAINS.—Which loosens accumulations of foreign substances so that they may be forced down through the goose-neck trap. Patent 1559,900. E. V. McCarthy, c/o Electric Shoe Shop, 1151 W. Madison St., Chicago, Ill.

LEDGER STAND.—Supported on casters, adjustable as to height, and by the use of which the lifting of the ledger is entirely obviated. Patent 1559844. C. E. Brooks, c/o Commercial Savings Bank, Mason City, Iowa.

INDICATOR.—Particularly adapted for use at gasoline stations for displaying the price of gasoline and calculating amounts representing various quantities. Patent 1560336. J. F. Dodd, 67 Lincoln Ave., Delaware, Ohio.

METHOD FOR AUTOMATIC AND RAPID PRODUCTION OF CRYSTALLIZED OR PRESERVED FRUITS.—Treating large quantities, and obtaining in three to four days, without handling, a crystallized marketable product. Patent 1560396. P. Navarre, 56 Avenue de Chatillon, Paris, France.

RAZOR-STROPPING DEVICE.—Whereby both sides of each cutting edge of a safety razor blade will be sharpened. Patent 1559897. F. A. Leigh, 827 Newport Ave., Chicago, Ill.

CHECK PROTECTOR.—Which is small, may be readily transported in the pocket, having serrated impression members for covering the numerical amount of a check. Patent 1561,423. J. Evans, c/o U. S. Naval Fuel Station, Melville Station, Newport County, R. I.

CORDAGE STRUCTURE.—Having a cover for the strands constructed to give greater strength than is the case in rope of ordinary construction. Patent 1561357. F. Riesenberg, Tuckahoe, N. Y.

LOW-WATER ALARM FOR BOILERS.—Adapted to be attached to a steam boiler of conventional construction, being actuated when the water falls to a definite level. Patent 1561135. W. MacA. Barbour, 709 Henry St. S. W., Roanoke, Va.

BOX CLOSURE.—For shoe blacking and similar pastes, which may be readily opened without the use of tools. Patent 1561330. A. H. Keller, P. O. Box 586, Pleasantville, N. J.

STAND.—Of pedestaled receptacle design, for use as a smoking stand, having rotary movement, a match box holder attached, and means for discharging refuse. Patent 1561,339. E. A. Maraffi, c/o Electrolite Products Co., 1143 De Kalb Ave., Brooklyn, N. Y.

CONTAINER.—Which will support a tube of tooth paste, shaving cream or the like, in vertical position thus preventing exudation. Patent 1561382. G. Walters, c/o Mount Royal College, Calgary, Alberta, Canada.

MANUFACTURE OF ROLLED METAL DISKS. Whereby the cost of production is greatly reduced and waste material is practically eliminated. Patent 1561346. F. Milliken, 44 W. 44th St., New York, N. Y.

CHECK VALVE.—With a minimum interruption of flow, the structure being such that the valve disk may be ground onto its seat at any time. Patent 1561395. E. T. Adams, c/o The Fairbanks Co., 416 Broome St., New York, N. Y.

GRATER.—Of the cylindrical type, having a removable member with a grating surface which permits of the device being cleansed without inconvenience. Patent 1561401. M. Bembina, c/o D. G. Vernaci, 44 W. 44th St., New York, N. Y.

SUSPENSORY.—So constructed that the sack may be readily renewed, and yet is properly supported when in use. Patent 1560753. W. J. Young, 564 N. W. 30th St., Miami, Fla.

DEVICE FOR CLEANING SMOKING PIPES.—Which will permit a powerful blast of compressed air, such as that obtained at automobile service stations, to be applied to the pipe. Patent 1560903. F. Eiche, 2000 S. 23rd St., Lincoln, Neb.

FLOWERPOT.—Which has novel means for draining any excess water from the pot, thus preventing the plant roots from rotting. Patent 1561824. H. M. Boehm, c/o Boehm Decorating Co., 252 First Ave. N., Minneapolis, Minn.

TUBULAR HOLDER.—In which an explosive charge may be lowered in the bore of a well or like place. Patent 1562123. E. L. Pitts, c/o C. C. Fisher, Okmulgee, Okla.

FLYTRAP.—Of extremely simple construction, which can be folded flat for storage or transportation. Patent 1561661. E. D. Pepper, 413 Edwards Bldg., Jackson, Miss.

STAMP HOLDING DEVICE.—Comprising a cup-shaped casing having a slotted peripheral flange and a plurality of spring fingers for supporting rubber stamps. Patent 1562369. A. W. Schmidt, c/o Consolidated Stamp Mfg. Co., 87 Maiden Lane, New York, N. Y.

DIRECT COOLING OF GOODS.—By refrigerating or freezing of goods through direct treatment with a cooled solution of inorganic salts, or both inorganic and organic matters. Patent 1562360. A. J. A. Ottesen, 14 Dosseringen, Copenhagen, Denmark.

WALL CONSTRUCTION.—Including an enameled sheet metal construction forming a substitute for the wainscotting, so that the surface will be waterproof. Patent 1562233. E. A. Hayer, 502 W. 122nd St., New York, N. Y.

ARTIFICIAL STONE AND PROCESS OF MAKING.—Which characterizes certain striated or veined surfaces, and simulates the age worn appearance, of the natural Roman travertin. Patent 1560450. R. M. Wesely, Los Angeles, Calif.

CLOTHES DRIER.—In the form of a standard with a plurality of radially extending arms, removable when not in use, and securely locked in use. Patent 1563137. G. Amsler, 201 W. Duncannon Ave., Philadelphia, Pa.

PIPE HOLDER.—Which is portable, and will hold a smoker's pipe in position to prevent the ashes from falling onto a desk or the like. Patent 1563210. J. H. McIntire, 276 Jefferson Ave., Brooklyn, N. Y.

ATTACHMENT FOR PENCILS.—Adapted to cooperate with a pencil of ordinary construction, without extensive changes, to hold a pen at one end of the pencil. Patent 1563,277. C. M. Haddox, 6 California Apartments, California Ave., Charleston, W. Va.

COMBINED CIGARETTE CONTAINER AND ASH TRAY.—Associated with a package of cigarettes of ordinary type, and when not in use has all the compact features of the regular package. Patent 1562497. W. R. Derry, c/o L. J. Fluker, 741 Green St., Union Point, Pa.

STRAINER.—Which will function to collect sediment in the bottom of the strainer, out of the path of movement of the milk. Patent 1562492. A. Brown, Plymouth, Wis.

BOOK COVER.—An auxiliary binding, formed in a single piece which can be conveniently applied to the regular binding of a book of any one of a plurality of sizes within considerable range. The inventor has been granted two patents, 1562504 and 1562505. E. W. Jackson, c/o E. L. Steck & Co., Austin, Texas.

Hardware and Tools

QUICK RELEASE SAFETY HOOK.—Comprising two complementary hook-shaped body members and two clamping springs, in addition to a swivel link. Patent 1561337. T. F. Madigan, c/o Collison & Co., 483 Collins St., Melbourne, Australia.

SAND RIDDLE.—Or screen, of woven wire, having regularly spaced upset portions, and flat portions between the upset portions. Patent 1563047. M. J. Somers, 13 E. Columbia St., Springfield, Ohio.

Machines and Mechanical Devices

UNIVERSAL JOINT.—Which is particularly adapted for use in the transmission of power where exceedingly heavy strain is to be applied. Patent 1556840. W. H. Kadesch, 1109 Main St., Cedar Falls, Iowa.

PRESSING MACHINE.—Especially constructed to obviate the wrinkling and constriction of the lower ends of tapering trousers legs. Patent 1558946. J. Tedford, N. E. cor. State St. and Jackson Blvd., Chicago, Ill.

CHECK PROTECTOR.—Which will automatically move a type into printing relation for printing the amount on a check, and mutilate the check to prevent unauthorized changes. Patent 1558869. C. A. Gulling and E. W. Cheney, 139 No. Va. St., Hoyt, Norcross, Cheney & Hoyt, Reno, Nevada.

MIXING APPARATUS.—Particularly adapted for mixing the proper proportion of lime with sugar juices. Patent 1558069. O. Prieto y Cruz, c/o Central Boca Chica, Inc., Apartado 169, Ponce, Porto Rico.

ONE MAN BOAT LAUNCHING APPARATUS FOR SHIPS.—By which one man can by himself launch a life boat ready to be filled with passengers and crew. Patent 1559534. C. B. Osbon, 107 College Ave., West Somerville, Mass.

BEAM REST.—For use in removing beams from warping machines, the rest being constructed to support the filled beam. Patent 1559434. W. Imbt, c/o Russell Imbt, Box 115, E. Stroudsburg, Pa.

MACHINE FOR PRINTING PHOTOGRAPHS.—Adapted for quantity production, the device being constructed to hold a number of plates, and sufficient paper for successive printing in series. Patent 1559438. A. M. Josepho, 16 W. 46th St., New York, N. Y.

MOTOR DRIVE FOR WRINGERS.—Which can be readily secured to a standard type of wringer, and transform the same from a hand-operated to a mechanically driven device. Patent 1560387. H. C. Law, Factory Lane, Hastings on Hudson, N. Y.

OIL CUP.—Having an automatic feed controlled by the temperature of the machine bearings, and feeding the necessary quantity from time to time. Patent 1560338. L. C. Dutro, 2020 Cerritos Ave., Long Beach, Calif.

MEASURING APPARATUS FOR BOARDS.—A timber-measuring device, which automatically determines both the dimensions and number of boards measured, and the sum of the values. Patent 1560392. H. Mager, c/o Urbantschitsch, 1 Tuchlauben 21, Vienna, Austria.

MACHINERY ALARM.—Adapted for use in connection with the clearance space of a reciprocating motor to indicate a reduction of the space. Patent 1557957. H. Amrhein, 335 W. 4th St., Oxnard, Calif.

HAND-PROPELLED BOAT.—The propulsion of which is effected by means of levers geared with the propeller at the rear of the hull. Patent 1559826. G. F. Winter, c/o The Lynch Co., Honolulu, Territory of Hawaii.

SAFETY VALVE.—Which may be readily attached to a gasoline tank to automatically keep the pressure within the tank at a predetermined point. Patent 1560457. J. E. Wood, c/o A. C. Anderson, 1911 Washington Blvd., Chicago, Ill.

PORTABLE PNEUMATIC GREASE GUN.—By means of which the amount of grease forced into the grease passage may be accurately determined. Patent 1559894. C. B. Lansing, Colorado Springs, Colo.

KEY.—For attaching pulleys and the like to shafts, having gripping members formed on the working face for engaging the shaft. Patent 1560399. C. F. Preston, Sr., Box 666, Mamaroneck, N. Y.

PATTERN-PRINTING MACHINE.—In which a strip of fabric, such as a bolt of cloth, may be printed with a plurality of patterns of the same nature. Patent 1560710. H. H. Meyer, c/o M. Katz, P. O. Box 55, Station "A," 113 Greene St., New York, N. Y.

EXPANDING PLUNGER FOR OIL WELLS.—To insure the tight fitting of the plunger in the working barrel and unfailingly producing suction for operating the pump. Patent 1561407. C. Card, c/o Mrs. C. Card, Box 27, Breckenridge, Texas.

VACUUM CLEANER.—Wherein intermittent suction draft is used, instead of a continuous flow, for lifting the dust from the surface being cleaned. Patent 1561321. M. Goodman, 9 E. 41st St., New York, N. Y.

COMPUTING BIN.—Particularly adapted for dispensing such commodities as sugar, rice, coffee, etc., by means of a measuring cylinder rotatable under the bin. Patent 1560824. I. S. Karras and D. V. Bridwell, Fargo, Ark.

GRINDING MILL.—Wherein the ground material is forced through a screen and deposited within a suction and discharge conduit. Patent 1560865. J. B. Sedberry, c/o The Bossert Corp., Utica, N. Y.

PUMP.—Especially designed for use with oil wells, so constructed as to provide an effective sand trap and gas anchor. Patent

1561049. J. H. S. Bonner and M. T. Chamberlin, Box 1191 Wichita Falls, Texas.

EXCAVATING BUCKET.—Capable of use either with a standard excavating machine or a so-called "slack line" cableway. Patent 1560895. F. T. Crowe, Guernsey, Wyo.

MACHINE FOR FORMING PAPER HAT RINGS.—As used in supporting hats when packed in a box for shipment and for preventing injury. Patent 1562368. B. Schiffenhaus, c/o M. Morris, 299 Broadway, New York, N. Y.

MACHINE FOR TURNING SHOES AND THE LIKE.—For automatically reversing a shoe or similar article, from wrong-side-out to right-side-out, or vice versa. Patent 1562282. D. Baum, 226 Newell St., Brooklyn, N. Y.

WALKING BEAM.—Having an auxiliary walking beam which rides upon the main beam to increase the stroke of the pump and thereby the output. Patent 1561723. J. O. Keefover, c/o H. L. Johnson, Gilliland Oil Co., Tulsa, Okla.

Medical and Surgical Devices

APPARATUS FOR TREATMENT OF THE EAR.—Pertaining more particularly to a device for treating certain diseases of affections of the ear with gases. Patent 1554876. R. McK. Nastasia, cor. Norwood Ave. and Wall St., Long Branch, N. J.

EYECUP.—Adapted to direct the liquid toward the sides of the eye when washing the same. Patent 1557620. H. Robinson, 325 N. 11th St., Waco, Texas.

DENTAL DEVICE.—Comprising a pair of adjustable jaws for determining the space between the gums for the adaptation of false teeth. Patent 1560904. J. Ellard, Texhoma, Okla.

LEG AND FOOT DEVELOPER.—An appliance that will make heel and toe walking more natural, restore defective muscles to their normal functions, and produce blood circulation in affected regions. Patent 1562294. J. J. Cooper, 56 W. 47th St., New York, N. Y.

TRANSMITTING MEANS FOR ULTRA-VIOLET RAYS.—By therapeutic lamps, in which the interposition of a vacuum between the lamp and the patient reduces the heat without affecting the short wave rays. Patent 1559,770. R. G. Paddock, 510 Stockton St., San Francisco, Calif.

Prime Movers and Their Accessories

MIXING DEVICE.—So constructed as to thoroughly break up or screen and gasify the combustible mixture as it leaves the carburetor. Patent 1557362. O. Harris, 134 Clay St., Hackensack, N. J.

STANDARD-UNIT MARINE CONDENSER.—For reconverting steam into water, in which only one header is necessary, the tubes being rigidly soldered to that one header. Patent 1556897. R. L. Leach, Box 852, New Orleans, La.

SPARK PLUG.—Particularly adapted to high speed engines, where a very considerable degree of pressure and high temperatures are reached. Patent 1559463. M. Sacchi, 28 Corso Valentino, Turin, Italy.

SPARK PLUG.—In which the core is rendered transparent and the spark visible from the outside to note whether or not the plug is functioning properly. The inventor has been granted two patents of a similar nature. Patents 1560510 and 1560511. L. Hirsch, 505 E. River St., El Paso, Texas.

SPARK PLUG.—In which a pair of electrodes are spaced apart, the terminals forming a spark gap in line with a space between two projections. Patent 1560512. L. Hirsch, 505 E. River St., El Paso, Texas.

SPARK PLUG.—Wherein a pair of sparks is provided with an isolated conductor interposed so as to insure a more complete combustion. Three patents of a similar nature have been granted to the inventor. Patents 1560513, 1560514 and 1560515. L. Hirsch, 505 E. River St., El Paso, Texas.

Railways and Their Accessories

LOCOMOTIVE CONSTRUCTION.—Having four cylinders and four drivers, the drivers being coupled to operate as one, accomplishing a gain in power and speed. Patent 1562284. F. A. Benolken, c/o Rev. J. H. O'Neill, Mount St. Charles College, Helena, Montana.

BRAKE.—Especially adapted for use with railway cars, the controlling means being operative at all times while the car is in motion. Patent 1561794. P. L. Peterson, Box 262, Manti, Utah.

AUTOMATIC SLACK ADJUSTER FOR AIR BRAKES.—Which is applicable to any existing type of air brake system, for periodically adjusting the brake shoes. Patent 1560980. W. S. De Camp, 348 E. Maine St., Chillicothe, Ohio.

METHOD AND DEVICE FOR BRAKING RAILWAY AND OTHER VEHICLES.—Which may be propelled by any motive power, to better secure the continuous controlling of brakes, more particularly in long trains. Patent 1562325. P. Hallot, 15 Rue du Plelo, Paris, France.

Pertaining to Recreation

GAME.—Consisting of a playing board and playing pieces, the pieces being constructed to partake of eccentric and startling movements. Patent 1562322. C. Gitchel, Kearney, Neb.

TOY WITH MOVABLE FEATURES.—In the form of a doll having a head, body and leg portion, and a sound producing device manipulated by vibration. Patent 1561829. I. E. Cohn, 65 4th Ave., New York, N. Y.

CARD GAME.—Having a plurality of main and honor suits, forming combinations resulting in a predetermined number of cards designating the winner. Patent 1562149. H. T. Cox, 5676 York Blvd., Los Angeles, Calif.

TEETERING DEVICE.—A toy which will amuse a child, and at the same time provide a safe healthful and exhilarating exercise. Patent 1562700. W. L. Herring, c/o F. E. Riddle, Mayo Bldg., Tulsa, Okla.

Pertaining to Vehicles

SIGN.—More particularly for use upon automobile doors, constructed of flexible material that it may be adapted to the door curvature. Patent 1557955. L. H. Young, Visalia, Calif.

BRAKE-ADJUSTING TOOL.—Which will engage the brake foot pedal for adjusting the same and varying the amount of depression. Patent 1558854. N. Falconer, 1342 Hayes St., San Francisco, Calif.

FRAME FOR LICENSE PLATES.—Which will minimize the non-aesthetic appearance of the usual license plate, and its mode of mounting. Patent 1561420. F. D. Elliott, 608 Carrie St., Sault Ste. Marie, Mich.

AUXILIARY FUEL TANK FOR AUTOMOBILES. So constructed that the driver must deliberately connect up the auxiliary, and therefore know that he is almost out of fuel. Patent 1561358. C. L. Sarnelle, 1663 W. 11th St., Brooklyn, N. Y.

PUNCTURE-CLOSING COMPOSITION.—For closing punctures or blowouts in inflated vehicle tires, the composition consisting of asbestos, slippery elm bark and water. Patent 1561332. T. E. Law, Mesa, Arizona.

SHOCK ABSORBER.—In which abrasive plates resiliently maintained in frictional engagement with a sliding plate restrains the movement of the sliding plate. Patent 1560594. D. F. McMahon, 5314 W. 24th St., Cicero, Ill.

SAFETY BRAKE LOCK AND BRAKE-LOCKING DEVICE FOR AUTOMOBILES AND TRUCKS.—For locking levers of either the emergency or foot brake type or both, to prevent movement of the wheels. Patent 1560582. F. H. Kagarise, 617 Pierce Ave., Sharpsville, Pa.

NEUTRAL DEVICE.—Especially adapted for Ford cars, which automatically insures the positioning of the speed control in neutral position, by means of a heel operated pedal. Patent 1561340. C. F. Marston, 1007 Franklin Ave., Brooklyn, N. Y.

CENTER EMERGENCY BRAKE AND CONTROL LEVER FOR MOTOR VEHICLES.—Which will equalize the pull upon the brake bands, and which may be easily attached to standard types of motor vehicles. Patent 1560636. G. C. Allen, 427 Virginia Ave., Joplin, Mo.

AUTOMOBILE RADIATOR.—Provided with a simple arrangement for tightly fitting the ends of the radiator tubes into an end casting to prevent leakage. Patent 1561695. C. Costelloe and S. G. Stoll, 915 Calumet Ave., Hammond, Ind.

REVOLVING NAME PLATE.—The plate being revoluble under the force of a moving current of air thereby attracting attention. Patent 1561830. W. C. Connell, R. No. 3, Box 70, Yakima, Wash.

LOCKING RING FOR SEPARABLE RIMS.—Which is flat, extends beyond the felloe for holding the rim, and may be easily secured or removed. Patent 1560756. T. D. Bryan, Linden, Calif.

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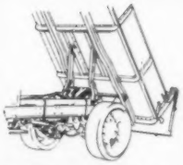
The last word



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The tapered dump body is hoisted on sturdy arm and link lifts by a safe, speedy and positive gear drive. It lifts to an angle greater than 50 degrees, dumping any load clean. The body is under positive control through rigid connections at all times. It may be held at any angle. It is lowered by the same mechanism that hoists it, but can be lowered with the truck in motion. At normal position and at extreme dumping angle the body is automatically stopped.

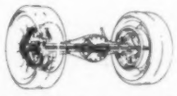
The body is mounted so that load weight is properly distributed and the dumping point is so far back that the load dumps cleanly over the edge of a soft fill without danger of miring the truck, or piles clear of the truck on level ground. Double-acting tail gate further facilitates dumping. Low body sides make loading from the ground easy.

The dumping mechanism sets solidly down in the frame in a dirt-proof and weather-proof housing. All the gears run in oil.

Auxiliary Low Gear

An auxiliary transmission gives you maximum power at all times—extreme flexibility of power. In holes, in mire, on hills it enables you to gear down to the hardest pull. It works independently of the regular transmission.

Power is transmitted in a straight line from starting crank to rear axle when operating under load. This insures maximum power and maximum life of all drive units.



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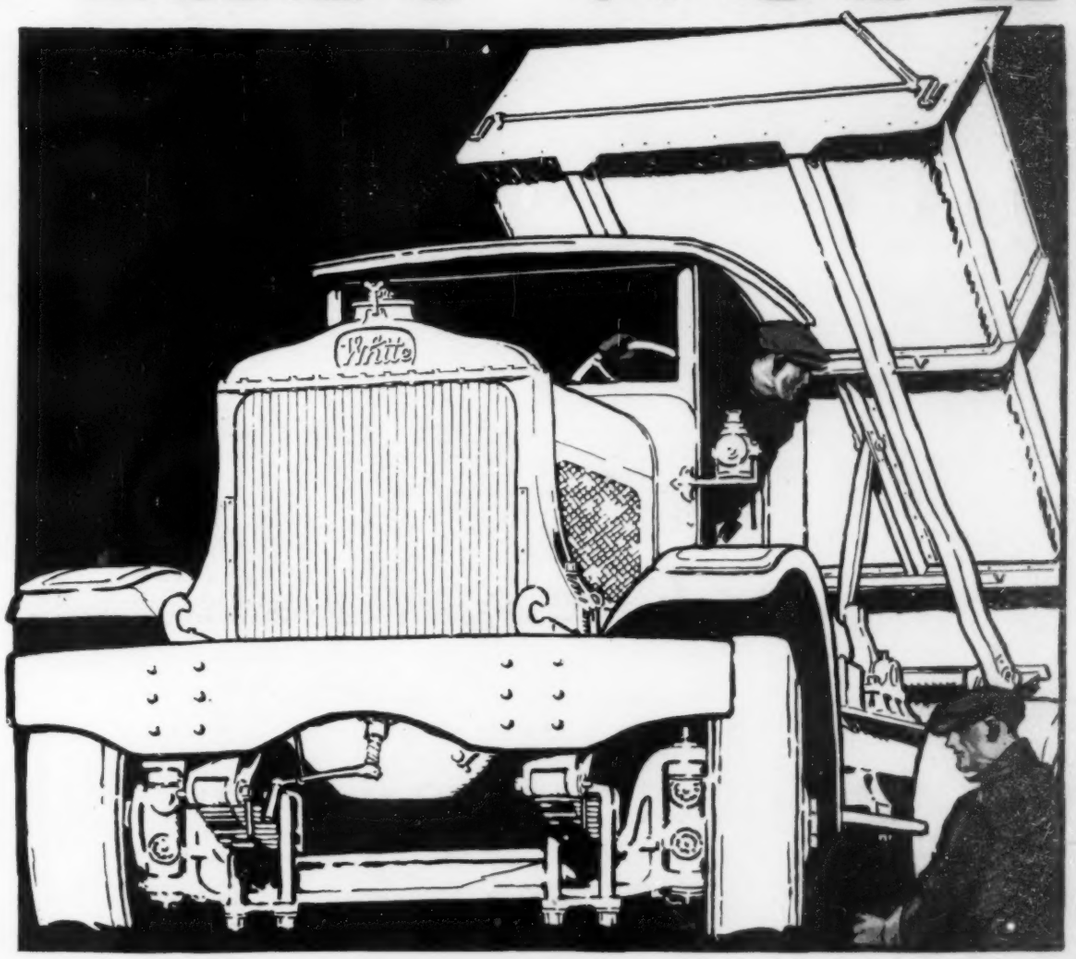
[illegible] run in oil. All of its [illegible]t. It saves time, man [illegible] It puts more of the [illegible] work.

[illegible]te Model 52-D the [illegible]r and safety that [illegible] operations de[illegible]ular-type radi[illegible] the frame; [illegible]umper; tow [illegible]teering; air [illegible] saves fuel [illegible] in all sea[illegible]akes with [illegible]t insures [illegible]g brake [illegible]cations.



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(White Model 52-D)

Anticipating the demands of industry

Turn this White loose on any dump truck job. The job is licked! . . . Put a load on it. . . . Stick it in a hole with steep sides or soft bottom. . . . Then slip in that auxiliary gear. Step on it. . . . It just walks out.

Dump? . . . It'll dump any load while you're thinking about it. Sure-acting gears and rigid arms hoist that tapered body to an angle so near straight up that the stickiest load slides out. . . . You can back up to the edge of a soft fill, dump clean and get away without miring. And on the level the load piles up clear of the wheels. . . . Let the body come down safely while you're speeding back for another load.

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A giant belt conveyor, whirling through a mountain, and carrying 10,000 tons of coal a day from mine to waterfront—it sets a thrift example for the whole world.

Equipped with G-E motors and automatic control, it almost runs itself. Each motor automatically starts its section as soon as the adjoining belt has attained full speed.

You may never need a wheelbarrow four mile long. The chances are all against it. But sor where in your factory, or office, or home, the a task that electricity could do better and ch The General Electric Company makes the ment to do that task.

The coal mines of the United States require nearly three million electrical horsepower. To meet this colossal demand the General Electric Company produces locomotives and motors for the conveyors that have displaced the poor old mine mule; it designs motors, large and small, for huge stripping shovels, loaders, fans, pumps, hoists and undercutting machines—all bear the monogram G-E.

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